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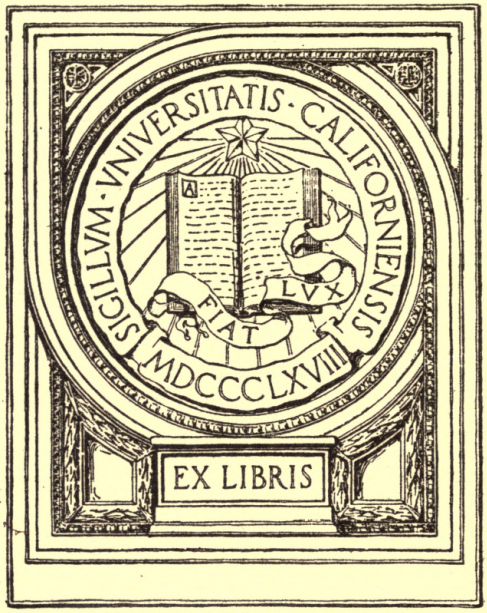
Practical Track Work

By KENNETH L. VAN AUKEN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Practical Track Work

(SECOND EDITION)

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(SECOND EDITION)

By Kenneth L. Van Auken

Railway Educational Press, Inc.
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Chicago : : : : : Illinois

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FOREWORD—SECOND EDITION

The first edition contained the following statements:

"The most of the material in this book at least has the merit of being original, the information having been obtained by the author through his own experience as a laborer and foreman engaged in track work. It is not intended as a complete treatise on the subject, information on engineering features of design having been purposely omitted as not of interest to the practical trackman. The young engineer in charge of track work, however, will find here information which will prove of daily benefit to him.

"It should also be understood that this book does not take up the subject of maintenance, as it would have been entirely too bulky if this had been included. The author hopes that this issue and future revisions will add some knowledge to a branch little touched upon heretofore—the organization of gangs, and the actual steps, illustrated by lucid diagrams, which must be taken in constructing track and switches."

The first edition of "Practical Track Work" was sold in about thirteen months—sufficient evidence of the demand for practical information on methods of constructing track and switches. As was to be expected, however, the first edition was not complete, nor was the arrangement the best. The deficiencies have been largely made up in this, the second edition, through the detailed criticisms of a large number of my good friends, the trackmen of America.

K. L. V.

August Fifteenth,
Nineteen Sixteen,
at Chicago.

CHAPTER I.

LABOR AND ORGANIZATION.

Supply and Demand—All those concerned with track construction and maintenance have felt the handicap of scarcity of laborers. The "Old Timers" will remember when there were two men for every shovel and they were intelligent and capable laborers too. In those days it was easy for a foreman to get the maximum amount of work done, because each man knew that there were many others to take his place. At present, the successful overseer of laborers is he who can thoroughly organize his gang and obtain work from his men while retaining their good will; and who can hold his men in spite of the demand for them in other industries. It is not necessary for a foreman to be lax in discipline to be popular with his men; in fact, strict discipline, maintained impartially, creates respect for the foreman. The demand for labor has led to an influx of foreigners, many of whom are intelligent and willing, and make excellent laborers and good citizens provided they are started right, educated or instructed as far as feasible, and subjected to good discipline.

Labor Agencies—The heavy demand for laborers led to the establishment of labor agencies. By paying a small fee the laborer could obtain work which it might take him weeks to find unaided. But many of the labor agencies were not satisfied with the legitimate profits which they were enjoying and began practicing questionable methods. Some railway companies through

favoritism or otherwise, designated that all their laborers must be shipped out by certain agencies. Many times has the hobo inquired in vain for a job from the foreman of a gang and later been sent to the same work after the agency had received its fee.

Exorbitant Fees—The object of the labor agency at first was to supplement the efforts of the foreman. Under present methods it is frequently a hindrance. Experienced laborers will look elsewhere for work rather than pay an exorbitant fee. Only green men, new arrivals in this country, or worthless men will pay an exorbitant fee for a job with a track gang.

Exclusive Agencies—If the object of a labor agency were only to obtain laborers, then the charge should be small and the foreman should be given the privilege of hiring good men wherever he finds them. When orders are given that all laborers must be obtained through one agency, it appears that the securing of laborers is secondary to the securing of fees. This results in enriching the labor agent and his organization at the expense of the company.

It is a bad system which prevents a foreman from hiring men whom he knows to be good track laborers. An experienced foreman is always acquainted with laborers of exceptional ability whose services he can obtain; men whose qualifications and limitations he is familiar with. The work of organizing a gang is greatly facilitated and the amount of work which can be accomplished is greatly increased when there are a number of such laborers, on whom the foreman is sure he can depend.

Misrepresentation—The man who pays an exorbitant fee for a job makes a poor laborer. The advantages

and ease of the work will have been misrepresented to the best of the agent's ability, with the result that when the laborer gets on the job he will be dissatisfied and unwilling. It will be natural for him to assume that it is impossible to discharge him since he has paid an exorbitant price for his job. The scarcity of laborers makes a foreman's work hard enough without the added disadvantages resulting from lack of control over the selection of men, instructions not to discharge men, and discontent caused by the misrepresentations of the labor agents.

Interpreters—Nearly all practical men—roadmasters, supervisors and foremen—are of the opinion that, far from being a help, the interpreter is a positive hindrance. The opinions of men writing for publications, as well as committee reports on the labor question submitted to railway associations, uphold this statement. Usually an interpreter arranges to furnish a certain number of men with the stipulation that he shall have charge of them as interpreter, and frequently with the understanding that he shall have the privilege of boarding them. While all these arrangements are being made, the interpreter will give profuse promises to obtain first-class men and to see that they do a fair day's work. But in practically every case the interpreter changes front when he gets on the job. In order to hold his authority over the men he tells them "to take it easy." He organizes the gang into a union in order to prevent the foreman from firing one man without losing the whole gang, but his main object is to get the support of the men and thus cinch his own job. The interpreter has often been found to exact graft from the men, justifying himself by explaining to them that he is more than earning his money

by lightening their labor and preventing the foreman from discharging them.

Since practically all those directly concerned with handling labor are agreed that interpreters are a hindrance, it should be an easy matter to eliminate them by the concerted action of the higher officials of a number of roads.

Transient Labor—One cause of the scarcity of laborers is the increasing number who follow no steady vocation, but stampede to locations where they can temporarily obtain high wages. Thousands of men are employed temporarily on railway maintenance or construction in the summer months, and discharged in cold weather. When business is good and receipts are high, an exceptional amount of construction will be attempted, and railways will be in the market for a large number of laborers. The demand being greater, higher wages must be paid and consequently the cost of the work is increased. If the amount of construction work done each year could be maintained on a more uniform basis, cheaper work could be obtained and the construction forces would be more efficient—and the track laborer would be given the benefit of steadier work.

If an exceptionally good gang could be kept on the payroll during the winter, a large "organizing expense" would be saved each spring. This would also reward the industrious and willing laborers who under the present system, as ordinarily practiced, are rewarded only by being discharged after the first cold snap. The conscientious laborer does not receive any increased pay, neither does he obtain more permanent work, on account of his loyalty. In the Northern States it is necessary to hire large gangs of men for shoveling snow during the winter months; a permanent extra gang could be used to

advantage in this work and also in clearing ice away from structures, etc. The distribution of the next year's material could also be made, thus forwarding the work of putting in ties, etc., in the summer time.

Year Around Work—It could not be expected that the floating gang would be kept on full time all winter, but seven or eight hours work a day with corresponding pay would serve to hold the gang together. Most railroads have hesitated to make many changes which would better the conditions of the track laborer, due to the legislative restrictions which limit their revenue, and to the fear of more severe conditions. So they have not felt it possible either to authorize a somewhat uniform amount of work for every year or to retain their competent track laborers the year around, with the exception of a few of the older men on the section gangs.

Recently, however, a number of railways have adopted the practice of relaying steel in routes, with satisfactory result. The Long Island R. R., in 1912, adopted a policy of permanent employment of track forces. Gangs are kept the same size the year around, and all work possible is done in winter.

Wages of Laborers—The average daily compensation of railway employees of all classes for the year 1910 was in the United States, $2.23; in Great Britain, $1.05. Excluding supplementary allowances negligibly affecting the average, the rate in Prussia-Hesse was 81 cents and in Austria 89 cents. The lowest-paid railway employee in the United States, the ordinary trackman, receives a greater compensation than many of the railway employees of France, even those of higher grades with responsible duties. The compensation of railway employees is from two to three times as

high in the United States as in Italy. It is well within the truth to estimate in a broad general way that while the cost of living of a railway employee in the United States is less than 50 per cent higher than that of a corresponding employee in Great Britain or on the Continent, his compensation averages over twice as much.

However, a comparison of wages of track men in this and foreign countries does not furnish a real basis for estimating the proper wages for track laborers. The comparison must be made with the wages of other classes of laborers, and the consequent demand for men in this country. Compared with other classes in the United States the wages of the track laborer are woefully small, and a substantial increase is necessary if the railways are to obtain and retain a fair class of trackmen.

Method of Obtaining Laborers—It is the opinion of many railway men who have to do with both track construction and maintenance, that present methods of obtaining and retaining laborers for construction work are either wrong in principle, or inadequate. If the labor problem is satisfactorily solved, the problem of future section foremen would also be solved, for there would then be plenty of intelligent, steady laborers to choose foremen from.

Choice of Laborers—There would probably be no labor shortage if the laborers in this country were employed on the work for which they are best fitted, and each did a fair day's work. Foremen who have handled gangs of different nationalities realize that there is frequently one kind of work for which a certain nationality is well adapted, and many other kinds of work for which that nationality is ill adapted. Even in men of the

same nationality, there is a great difference in the adaptability of each to different kinds of track work, and the way to get the proper men for each class is to have a labor bureau whose business it is to keep in close touch with the conditions both in the field and in the labor market. A commercial agency will send out a sewer digger on a track gang in preference to a good track man, if the former will pay a larger fee. A labor agency will send out undersized men, weak men physically, mentally and morally, if they will pay the fee.

Suggested Method—A system which would tend to give satisfaction if properly followed, might consist of:

(1) A company labor bureau;

(2) Company boarding camps and commissary.

(3) Graded rates of pay for section laborers, graded upward from present rates.

(4) Provisions for educating employees;

(5) Promotion (always) according to ability;

(6) Combination of construction and maintenance forces, to be permanently employed, as far as possible.

With a complete and efficient organization as outlined, laborers can be obtained who will remain permanently with the company, and such men certainly would be worth the trouble involved in working out such a system. Conditions are so bad that further retrogression must be arrested, and radical methods are required.

Company Labor Bureaus—All this can be changed and except in rare cases only will be changed, by hiring men through a company labor bureau; and this department should be put in charge of an expert trackman who has the wide knowledge which can be gained only from experience and observation—one who will keep in the closest possible touch with the requirements and

developments on his own and other railways from day to day. The company labor bureau, if efficient, could eliminate the interpreter (and that is greatly to be desired), could prevent extortion from laborers, and many other abuses. This would result in a great increase in individual efficiency.

Is there not a great inconsistency in hiring expert foremen, and then allowing any derelict to hire the men for these expert foremen to handle? The matter of first importance in manufacturing is the procuring of raw material which will best serve the purpose. At present few railways hire their laborers that way.

The maintenance of way department of the Baltimore & Ohio established a free labor bureau in August, 1912, with main office at Baltimore. Shortly afterwards small branch offices were established at other points. The original intention was to secure men for the maintenance of way department only. A short time later, however, the service of the bureau was extended to secure men for other branches of the service, but the bureau is still used principally to obtain trackmen.

In August, 1913, the labor bureau was put under the jurisdiction of the bureau of employment and is no longer under the supervision of the maintenance of way department. Its affairs are administered by a chief labor agent at Baltimore. He has an office assistant, who also does scout work, and three assistants who travel from point to point where laborers are available. Attached to the bureau are men who act from time to time as pilots for large gangs. These men have had wide experience in this work and they keep in touch with available gangs.

Newspaper advertisements explain the requirements and acquaint the public with the location of the labor

bureau offices, but in addition there is a man called a scout who distributes cards throughout the city, advertising the jobs for which men are sought. For all jobs except those on track, the applicants must fill out the standard application blanks, which are then investigated by the employment bureau, the men being taken on temporarily pending the outcome of the investigation. All men accepting employment must pass a physical examination.

Each man, when hired, is given a card which identifies him, the card having a number, stating the class of work the man is engaged for, the rate of pay, destination and approximate time of shipment. The pass issued for the man has a duplicate of the number on his card so that the conductor can identify the laborer. Pilots are sent with large gangs which are to be shipped a long distance, and also with gangs of foreigners, if they are unable to speak English. The conductor takes care of the men on short shipments.

Since the demand for laborers is great, there has been but little choice in the acceptance of men. The division people call on the labor bureau frequently and favor the plan very much, but the most of the men sent out are for extra gangs for temporary work and they are laid off when the job is completed. The laborers favor the plan because no fee is charged. The labor bureau has not undertaken to better the conditions of supervision or living for the laborers, this being handled by the division people. Judging by the favor in which the labor bureau is held by the division officials and the laborers themselves, it is a distinct success.

Company Boarding Camps—A boarding camp or commissary is almost necessary if foreigners are to

obtain anything like value for their money. The concessions of cars, bunks, etc., made by railway companies to their laborers (ostensibly) are really being made to the parasites who live off the laborers. Some nationalities, naturally economical, will cut their necessities down to a starvation basis when their purchases of supplies carry a heavy duty to some go-between, either the interpreter or the labor agent who reserves the commissary privilege.

The furnishing of good board would involve little, if any, increase in cost to the railway company. Practically every gang of foreigners has its cook or cooks, who are enrolled and paid by the railway as laborers, but never leave the camp. Two cooks with a gang of only thirty or forty men are not uncommon. If the company furnished board for the laborers, the wages paid together with money received for board of these men, would easily run the camp.

The benefit to the white laborers, the hobos, would be great if the company furnished good board and lodging. The hobo, even if improperly fed, can accomplish much work with the minimum of supervision, because of his track knowledge, intelligence and skill. His efficiency would undoubtedly increase if he were treated in a way which would keep him more satisfied. Good camps and food are as important, as wages.

Graded Rates of Wages—A man is entitled to increased pay with increased efficiency, but under present conditions the green track laborer generally receives as much as a laborer who has been in track work for years. In fact, an extra gang laborer usually receives more than a section laborer, although the former may have never worked on a railway before. Under these conditions

there is no reward if a man increases his ability and efficiency. Track laborers' wages should be increased in proportion to increased efficiency and length of service. This would produce an incentive for the laborer to become more proficient. Such a system would do away with the need for special apprentices, the highest paid man or men being the next eligible for promotion.

The unskilled man working under the graded system of wages, would receive pay only commensurate with the amount of work he accomplishes, and the experienced man would receive the larger wages to which he is entitled. There would then be some reason for laborers to remain in the service; after having attained the high wage class through years of service, they would be loth to lose their rights by quitting for some temporary increase in another industry.

Having established graded rates of pay, no deviation should be allowed. The rate should be adjusted so that the most efficient men would receive a specified wage, as a minimum, after having been in the service a certain length of time. And if a man increases his value more than the average his pay should be increased above the minimum. Promotions from laborer to foreman should be made only from the men in the highest paid class, and from these according to comparative ability. A deviation from this rule would soon spoil the system, for fair treatment must be insisted upon in any organization if the highest standards are to be attained. It is poor policy to keep a man on one job because he is useful to his superior, when a better position is given to another of less or doubtful ability. Such a policy is sure to become apparent and results in loss of loyalty.

Instruction—The kind of laborer who is most use-

ful is the ambitious one who has a desire to increase his capacity and ability, and thus merit increased wages. Such men should be given every opportunity to better and fit themselves for higher positions. For this reason some means should be provided for educating laborers and section foreman. This would form a bond between the laborer and the railway, would help to retain laborers in its employ; and finally would result in greatly increasing the accuracy and legibility of the many records and reports which a track foreman must make out.

(4) **Foreman's Treatment of Men**—The day of the profane and wordy driver of men is over. It is impossible for a foreman of this type to keep a gang of men in these days of labor scarcity. A foreman must be energetic, not indolent, and must constantly devise methods to hasten the work and eliminate lost motion. Neither is there a place for the foreman who is over indulgent or too familiar with his men. Nowhere is the old saying, "Familiarity breeds contempt" more aptly illustrated than in the relations between foreman and laborer. When a gang of laborers has a feeling of comradeship with the foreman, discipline ceases.

The position requires a man with unlimited patience, but one who exacts strict obedience while treating his men as human beings. Discipline is not loud talk; in fact some of the quietest men exact and obtain the strictest obedience. A gang which is well organized and well disciplined will remain on a job long after the poorly disciplined and poorly organized gang has left. It is human nature to dislike to work for an incompetent or a weakling. On the other hand it is surprising what can sometimes be accomplished with a gang working in a desultory manner when the men begin to see that their

every move is resulting in the greatest progress for the energy expended. Gradually interest is awakened, and once the interest of even the poorest class of labor is aroused, the results can be doubled or tripled. The first feeling toward a foreman who "means business" all the time, is quite likely to be one of dislike; but if a little tact is sprinkled in with discipline, this feeling can soon be changed to respect and the foreman who has the respect of his men will retain them in his employ, other conditions being favorable. Organization and discipline go hand in hand. Proper organization guarantees the greatest results for the amount of energy expended, and discipline is necessary to obtain proper organization.

Discipline should be tempered with good judgment. As an instance, the general foreman on a new line, many miles from "civilization" discharged an interpreter. The result of this discipline was that the entire gang quit work until the interpreter was reinstated, and since a new gang could not be obtained immediately, and it was absolutely necessary to keep a gang on the job, the general foreman was forced to reinstate him. Of course this act destroyed the foreman's discipline over the gang. Many times such a crisis can be passed over by using a little tact and not getting into a situation where it is necessary to make a display of authority. Then later, with the laborers in a different mood, the necessary order may be safely insisted upon. This does not mean that the wishes of the laborers should not be crossed, but it does mean that it is folly to arouse the antagonism of a gang for a trivial cause, or just to show authority; and this is especially true when the laborers are in a bad humor, as they are likely to be when surfacing in muddy ballast, when working in a rain or under other unfavorable conditions.

If a foreman makes a study of and adapts his methods to the particular characteristics of each man, he will gain the good will of the laborers and be able to retain them much longer than if otherwise treated. Some men must be driven, others will work on suggestion alone, others must be led, and still others must be influenced by instruction and example. Housing conditions, working conditions, rate of pay, etc., all have their effect on holding or driving away laborers, but the characteristics of the foreman, as evidenced in discipline, organization and intelligence, are of very vital importance in the solution of the problem.

Combination of Forces—A combination of maintenance and construction forces exists on some railroads, but on many these organizations are entirely separate. The combination of the two produces first, harmony instead of rivalry, and second, it provides a way of obtaining steady foremen from maintenance work for extra gangs—men who can be relied upon. Maintenance men could thus be given an opportunity to obtain a much broader knowledge, which would help maintenance. Such men, when promoted, are qualified to take charge of both construction and maintenance. When an outsider is appointed foreman of an extra gang, which usually pays higher wages, an injustice is done not only to the employee, but also to the railway. The permanent employee is entitled to the reward of his labors and the railway benefits through the loyalty of such an old employee wherever placed. The investing power of promotion in the foreman will result in some abuses unless he is the right sort. The only feasible way to preserve discipline in a gang of men, however, is to make the foreman practically supreme. When a superior gives

orders to laborers, promotes or discharges them, he weakens the foreman's control over his men. The solution is to employ honest foremen and not interfere with the laborers. A great deal can be accomplished by the attitude of superior officers. A policy of fair dealing on their part produces a similar spirit in the whole department.

A system as outlined above would, we believe, result in building up a strong organization in a comparatively short time. Abuses might arise, but few are likely if the policy is carried out fairly and confidently. It is of course impossible to find any system in which there will not be a few persons who will take advantage of any liberties accorded them. It is also realized that no simple system can be evolved which will cover all conditions, and in the system outlined above, changes, additions or eliminations might be necessary in individual cases.

Organization of Track Gangs—The value of thorough organization is not fully appreciated by all track men, but it is a matter which repays manyfold the most careful consideration and close attention; for it is the proper disposal of men which more than any other one thing affects the amount and quality of the work done. It has been said with truth that a gang of poor workers well organized will accomplish more than a gang of good workers poorly organized. Time and confusion are saved by assigning each man a task and requiring him to remain where he is placed until otherwise ordered.

Proper disposal of men implies in general that each one be placed on the kind of work for which he is best fitted, and in which he has had experience. However, this does not mean that more men than necessary should be used for bolting or too few for spiking. If there are too many

bolters and too few spikers a foreman will show his ability by picking out of the surplus bolters the men who can be quickly trained to become expert spikers. Men of great strength are not necessarily required, for an experienced man of less than ordinary strength who is intelligent and active, can accomplish more than a much stronger man who is awkward. Fully as important as physical strength is the workman's disposition, age, willingness, natural skill, intelligence, and experience.

The Individual Laborer—After the gang is correctly organized, the total amount of work accomplished depends upon the amount of work accomplished by the individual man, or by the different groups of men. The foreman should attempt to get a good day's work out of each laborer; he should carefully study the general characteristics and traits of the particular class of men he is working, and he should also become familiar with the individual skill and traits of each man, and then use him to the best advantage. Some men will do the most work if treated with familiarity, while others will not respect a foreman who takes this attitude.

The best men should be placed in the lead in each kind of work, and wherever possible the men should be placed so that each will have to do an equal share with the head man, or else fall behind the rest. This should not be construed as advocating the practice of hiring men at higher wages to lead off the rest of the gang. It is characteristic of the laborer experienced in track work, especially the hobo, that he does not like to admit the superiority of another. When such a man is placed so that the amount of work he accomplishes is directly measured by the amount other men accomplish, he will do his share.

Handling Laborers—The track foreman must not ex-

pect 100 per cent efficiency from an inexperienced laborer and he must devote more attention to him than to an experienced man. Track foremen may be divided into three classes: (1) the hustler; (2) the brainy foreman who maintains a steady but medium gait, and (3) the man who combines both brains and hustling ability. Frequently the hustler does a lot of extra work because he does not plan out in advance the proper order in which to do it. The foreman who uses his head may work less and accomplish more than the foreman who always hustles without planning his work. If a foreman uses his head and plans his work, and then pushes it hard, he will accomplish the most. Because a man is a hustler, then, is not an infallible sign that he is a first-class foreman.

A foreman should not be touchy and thin-skinned, for constructive criticism is necessary in developing a good trackman. He should always be ready and willing to do more than he is actually required to do, for then will he be worth more money to the company. He should be an enthusiast about his work, as this will not only increase his ability, but make his position more enjoyable and less like drudgery.

The greatest amount of work can be obtained from most gangs by treating them considerately, and this policy makes the work more pleasant for both laborer and foreman. The policy of "driving" men is being discontinued, for laborers will not stay on a job where subjected to such treatment. A further reason for treating laborers as human beings is that when it is necessary to do rush work, the men will be inclined to do their best and will then pay more attention to sharp commands and a limited amount of necessary driving. When the gang is separated and it is impossible to keep all men under close

supervision, those who have been treated right will work better than those whom the foreman has been constantly trying to drive. If men have only fear of their foreman, which is the case when he is a driver, they will use every possible chance to "soldier."

The foreman's discipline, however, should be strictly maintained under all circumstances. He should personally see to it that each of his orders is obeyed. In case an assistant foreman is employed and the laborers are all working together, orders should in general be given to the laborers by the assistant foreman. This will prevent conflicting orders being given to any man. The assistant should be backed up in every case by the foreman and his orders never reversed unless it is absolutely necessary. The laborers' respect for both foreman and assistant are increased in this manner.

Laborers of any kind note quickly whether the man directly in charge of them knows his business or not, and whether he stands in the good graces of his superior. If he does not, they are sure to lose their respect for him, with the result that the discipline of the organization is destroyed. For this reason the foreman should not, in general, take his assistant to task in the presence of the laborers, but should always have it appear that the assistant is proceeding in accordance with his wishes.

Maximum Supervision—In order to allow maximum supervision, the men should be kept as close together as possible without having them interfere with each other. Laborers may become scattered because of poor gang organization or irregularities occurring in the work, and the foreman will show his ingenuity by arranging the work and the laborers so that the gang is kept compact. If it is impossible to keep the gang from be-

coming scattered, as may happen on some classes of work, the foreman should be prepared to designate men of special ability to oversee each portion of the gang.

Laborers should be kept in good humor, as they will then accomplish more and do better work. It is also advisable to use methods which make the least demand on the strength of the men, provided such methods will not decrease the amount or lower the quality of the work. By following such methods it is possible to arouse the laborers' interest in the work, and this will tend to build up an organization which will accomplish good results even when it is impossible to give close supervision.

Trackmen Skilled Laborers—The policy of the railways of paying very small wages and treating good and poor men alike, has led to a general feeling that track men are unskilled laborers. As a matter of fact expert track men are skilled laborers, and for this reason they should be kept in the employ of the company permanently and not laid off on account of slack work.

New Methods—It should be the aim of the foreman to constantly look for and evolve new ways of doing work or to standardize ways and methods which have proved to be best. When the work is reduced to a routine, each laborer knows what is expected of him, much time is saved and much confusion prevented.

CHAPTER II.

TRACK TOOLS.

Good Tools—The importance of having good tools, taking good care of them, and keeping them in repair is evident in almost any kind of construction, and track work is no exception to the rule. Poor tools are a poor investment, for the amount of work accomplished with them is undoubtedly less than with good tools, and the quality of work done is inferior. It is also evident that poor tools will not last as long as those of a better quality, and especially when a tool must be used constantly, first cost should be a consideration secondary to quality.

A poorly designed claw bar, one with the claws dulled or chipped off, or one which has been carelessly repaired or tempered, generally requires a hammer-man, an additional laborer. In addition to the extra labor required, there is excessive battering of and early destruction of the claw bar. Since the hammer men are usually inexperienced and unskilled, they are likely to break spike maul handles frequently. Thus poor tools require more labor and are subject to greater damage.

The above instance shows how the number of laborers can be reduced by having good tools. A good tool makes possible an increase in the amount of labor accomplished per man, and if this increase is only five per cent over that of a poor tool, and that is certainly a small estimate, the increased cost of a good tool will soon be balanced. This is especially true of tools which are used every working day of the year.

The track foreman should in every case specify the brand of tools which he wishes. Giving the foreman this responsibility will help to get better results out of the tools which are furnished. Furthermore it will result in improvements being suggested which will develop track tools better adapted to the work. Another reason why track foremen should specify the brand of tools is that it is impossible for a salesman to "put it over" on a large number of these men—he cannot see a very large proportion of the track foremen. Then if meetings of foremen are held and tools discussed, the majority of the men will give opinions based on the service given by various tools instead of opinions formed by the claims of the salesmen.

The foreman must look after and take care of his track tools so that they will be kept in serviceable condition. Tools which are in good order increase the output of the gang materially and are particularly necessary in emergencies when work must be done in a hurry. If looking after the track tools is delegated to some laborer, the foreman should supervise the matter very carefully to see that the man is doing his work right.

Given good tools, it is of great importance to use them carefully, and to repair them or have them repaired when necessary. In a large gang it is advisable to have one man who is held responsible for the condition of tools, and for keeping track of them. Such a man, if he is intelligent and experienced, can keep the tools in such shape that the increased amount of work accomplished will more than pay his salary. And a clear profit will result from the avoidance of the delays which are so frequently caused by lack of tools. The foreman who does not take care of his tools should be dismissed.

Laborers should not be permitted to hide tools to keep for their own special use. Such methods are likely to result in a man being unable to find a monkey wrench or some other necessary tool when called out to repair a switch at night.

A foreman should not keep a large number of extra tools at his tool house; nor should he keep broken or unserviceable tools—they should be sent to headquarters so that they can be repaired or sent to sections where they are needed.

Ordering Tools—One of the most necessary things in handling materials and tools is to have a clearly defined system of ordering, furnishing, delivering and receiving them. A good way is to have the foreman check up his tools and make requisitions, which are filled by the supply car which goes over the road once a month. It is a good idea for the supply car to collect old tools in exchange for new ones as this makes the foreman more careful. The supply car should be sent out about the same time each month and the foreman should be sure to have tools which are to be repaired, ready to be loaded when the car arrives.

Full Use of Materials—The track foreman can make a very considerable saving in the materials which he uses in a year's time. In cutting rails he should always use the shortest rail from which he can obtain the desired length. When distributing spikes, bolts and nut locks he should not allow them to be placed where they will be buried or hidden from view and left. Ties should be carefully inspected and those which will be serviceable for a year or more should not be removed. Tools should not be discarded which can be sharpened or repaired and made as good as new. Keeping hand cars or motor cars

in good order with all nuts tightened up will prevent the loss of parts and save the cost of replacing them. The track foreman should keep his track chisels, axes, adzes, scythes and drill bits sharp, as this will make it possible for the men to do more and better work.

Keeping Tools in Repair—Adzes should be used carefully or they will become almost useless in a short time. Even an experienced man will frequently hit a spike stub, and inexperienced men will often hit the spikes and the rail. The best adzes should be saved for use in emergencies. When dull, adzes should be ground on an ordinary grindstone, or sent to the shops for resharpening.

Level and spotboards should be used carefully so that the bubble tube will not be displaced or broken. The accuracy of these tools, and the track gages, is largely responsible for the degree of excellence of the finished track.

A track chisel should receive only light and square blows when cutting a rail. This precaution is especially necessary with a new chisel or one recently sharpened and reground, as it is likely to chip and become spoiled with the first blow. When cracking a rail, a dull chisel should be used which will not be spoiled by heavy blows. Track chisels should be inspected often and those which are unfit for use should be sent to the shop to be retempered and sharpened.

If a track gage is not handled correctly, it is likely to be sprung so that it will not indicate correct gage. The gage should never be driven to a bearing with a hammer, nor should it be set against a rail which has been sprung out considerably with a bar, unless the rail is held away by the bar until the spike has been driven. Before using

a gage, it should be measured with a steel tape line to determine whether it is standard,—4 ft. 8½ in.—out to out of the lugs.

A rail drill should be handled only by experienced laborers. The machine should be carefully set for each hole, and the bits should be sharp or the machine will be subjected to an extra strain. Dull drills retard the work exceedingly and make it harder for the laborers.

The use of rail forks makes the handling of rails on cars or in piles easier, increases the number of rails handled and generally decreases the number of laborers required.

The rail tongs provided should be all of one pattern. The best kind are those which carry the rail close to the ground, just high enough to clear other rails or ties. Tongs which are not of the same size, or on which the clamps are not a uniform distance below the handles, will cause the load to fall very heavily on some men and lightly on others.

A rail bender should have the threads well oiled when used for putting a "stock" in rails. The use of oil makes the kinking of a rail easier, but after being oiled the bender must be taken care of to prevent dirt sticking on the oily threads.

Spike maul handles should be carefully hung by a man who understands the requirements. In order to get the maximum and most satisfactory use of the tool, the handle should have a snug driving fit. A long thin iron wedge made especially for the purpose should then be driven in the end of the handle to wedge the head on. A spike is too blunt, and a nail makes a poor wedge.

A tie fiddle is seldom furnished in an outfit of tools, but can easily be made with a saw and hammer. A cleat

is nailed across the end at right angles to a short board; the standard distance that the ties are to project beyond the rail base is marked off from the inside edge of the cleat, and the board is sawed off on this line. When placed on the face with the cleat against the end of the tie, the uncleated end of the tie fiddle shows the correct line for the outside of the rail base. The tie fiddle is an exceedingly useful adjunct to the tools of a track gang.

A tie pole is made by marking off the proper or standard spacing for the ties on a board or iron rod. The pole is usually made the same length as a standard rail, so that

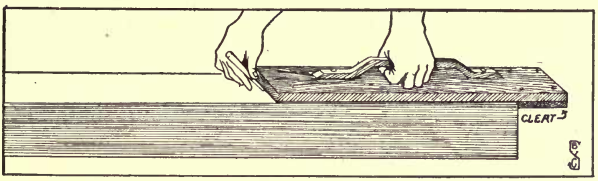

Fig. 1— Tie Fiddle.

Spot-Board Bracket.

the joint tie centers may be layed out properly on it. The pole should be carefully measured so that uniform and correct spacing will be possible. If it is desired to have a spacer which will take care of several rail lengths of track, a wire rope or cable would be very useful. The standard spacing for several rail lengths could be painted on in white paint; this tie spacer would not have to be moved so often and would make it possible for the tie spacers to work a long way ahead of the rail gang. The rear rail length of this rope could be left unmarked, and the spacing done entirely ahead of the rail gang.

A hook gage is frequently made of a board with four cleats which clasp the balls of the two rails and hold them

to gage for the iron car. This tool is seldom furnished in a kit of tools, but if properly made and used is a great labor saver.

Track wrenches, when new, are likely to be too small between the jaws to fit over the nuts. In hot weather they may be spread in the following manner: Place the jaws of the wrench flat on a rail, and hit the shank just back of the jaws with a spike maul several times. In cold weather the wrench must be heated a little or it may break when struck with a hammer. The jaws should not

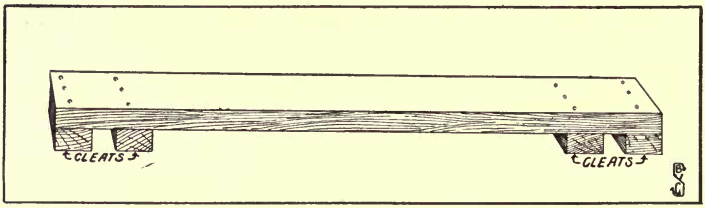

Fig. 2—Hook Cage.

be widened further than necessary to make a very snug fit, as the tendency in use is to become wider.

The foreman should not allow laborers to hammer a new or a good claw bar to drive it under spike heads. If spikes are old and hard to pull, one particular claw bar should be detailed for the purpose, and the rest saved in good condition.

Tool Boxes—Tool boxes should be kept in careful and neat order, so that the tool man or foreman can obtain any tool instantly when needed. Careful placing of the tools will double the capacity of a tool box. Heavy tools such as lining bars and spike mauls should be put in the bottom and light tools likely to be bent or broken should be placed near the top. An ordinary wooden box

will soon be knocked to pieces unless tools are placed in the box and not *thrown* in. It is generally advisable to have the laborers pile their tools up to one side and have the tool man place them in the box.

Loss of Tools—Tools if not watched are likely to be borrowed by other track gangs. Axes, cold chisels, files, saws, lanterns, monkey wrenches, nails, oil cans, padlocks, picks, shovels, tape lines, water pails and dippers are of use to outsiders and may be stolen if not carefully looked after.

Tools which are easily lost and which should therefore be checked up daily, are cold chisels, crayons, expansion shims, files, axes, saws, oil cans, drill bits, spike pullers, rail forks, track chisels, track wrenches, spike punches and center punches.

Too much stress cannot be laid on the necessity of caring for tools. Even aside from the question of economy, the necessity for good tools on rush jobs, and the advantage of having good tools on all ordinary jobs, should be sufficient to make each foreman jealously guard and care for his tools.

Hand Cars*—It hardly seems necessary to comment upon the operation of ordinary hand cars and speeders. But the scarcity of easy running and properly cared for cars which a foreman finds as he moves from gang to gang and railroad to railroad would seem to indicate that there is something radically wrong somewhere. The majority of men dismiss the subject by assigning the reasons of "carelessness and neglect." True, this accounts for a large proportion of the trouble, but experience shows that not less than half is due entirely to ignorance.

*Abstract from an article by Claude L. Van Auken, published in *Railway Engineering.*

Many handcar and speeder pumpers are perfectly willing and would be anxious to properly care for their cars if they knew how to put them and keep them in easy running shape, so as to lighten the labor of pumping.

Most handcars are manufactured with the idea of making them light running, and consequently the majority of new cars when received are squared up and true. However, if they are not, they should be tuned up by loosening the bolts which fasten the boxes in which one of the axles revolves, and moving one end of the axle for-

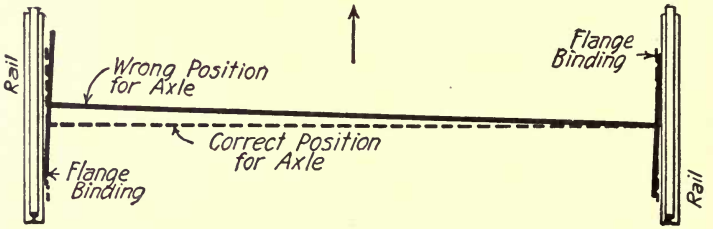

Fig. 3—Hand Car Axles in Incorrect Position.

ward or back to a position where there will be no tendency for the flange of any of the wheels to bind against the rail when the car is moved forward on straight track. (See Fig. 3.)

Wheels Binding—Flanges binding against the rail cause more hard pumping than any other single defect. When the axles are in the proper position, the bolts should be tightened firmly and kept tight. Handcars should be tried out frequently to see if they are true, as setting cars off and on the track, pushing them loaded with tools over highway crossings, rough handling, etc., are very likely to loosen and move the boxes from their proper positions.

Binding may also be caused by a wheel not running

parallel to the track, although the axle may be in proper position. (See Fig. 3-a.) This in a new car is clearly the fault of the manufacturer and should be remedied in the shop. Binding occasionally is caused by a crooked wheel. If the wheel cannot be straightened and trued up a new wheel should be obtained.

Front and Rear—Most handcars have their front or rear ends marked, and if the wheels and axles are properly trued up the car will always run lighter when placed on the track with the front end in the direc-

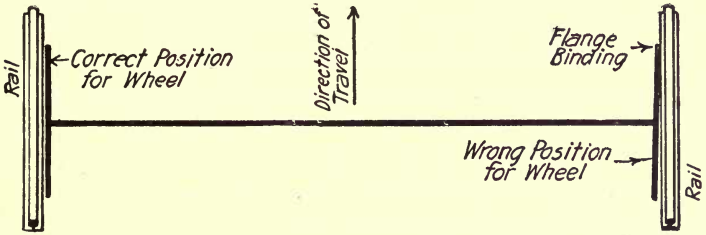

Fig. 3a—Hand Car Wheel Flange Binding.

tion of travel. This is especially true when running around curves. All wheels except the loose wheels should be keyed tightly to the axle and not allowed to work loose or get out of position so that they may bind. The loose wheel should be painted a conspicuous color or otherwise marked so as to be readily recognized, and the car should always be turned by lifting the end opposite to the end with the loose wheel. Proper lubrication of the loose wheel reduces the work of pumping around curves, as it allows easier adjustment to the unequal distance traveled by the inner and outer wheels.

Grinding—Next in importance to binding comes grinding. Grinding in the bearings may be due to lack of

oil, but it is safe to say that more frequently it is because of dirt and sand in the bearings.

Handcars should not be used for transporting sand and gravel, but in case it is absolutely necessary to use them for this purpose, the bearing and oil holes should be protected by boards or tin strips, or by plugging up.

Oiling—Exterior surfaces around bearings and oil holes should be kept clean of oil and grease, otherwise dirt will accumulate. The cogs of the gear wheels of either a speeder or handcar should never be oiled. While good, clean oil will reduce friction between the cogs, it will also cause an accumulation of dirt, sand and cinders and before long the teeth will be choked with a hard, gritty mass which will cause the car to drag, even down grade.

Bolts and screws holding the frame together should be kept reasonably tight, but not too tight, especially where the heads or nuts and washers sink into the wood. Unless the nuts on the underside of the platform are tightened occasionally, especially those with which oil comes in constant contact, they will jar loose and the lower half of the bearing box may drop off unnoticed. Hand car boxes and nuts should always be kept tight enough to keep lost motion at a minimum for easy running, and the cars should be oiled each day. Cars which run easily save the strength of the men, and also save time. Hard-running cars breed dissatisfaction. The push car should also receive frequent attention and oiling.

The motor car is displacing the handcar to a large extent, except on 4-track or heavy-traffic lines where the sections are short. A good motor car is a profitable investment for a long section.

Motor Cars—The use of gasoline section motor cars on

railways has been recommended by many progressive officials who concede that they make for ultimate economy. The first requirement necessary for success in the use of motor cars on railway work is to select a car that is suitable. Obviously a light inspection car should not be selected to carry four or five men and pull a speeder behind carrying one or two men; and vice versa, a heavy section car should not be assigned to the use of two men, especially on lines of heavy traffic, because of the difficulty of handling and the increased likelihood of the car being run down by a train.

Operators—Assuming that a suitable car has been selected, the next essential thing is that one man among the users be selected as an operator to run the car, instead of allowing different men to operate it. If a car is operated by any one of several men, each considers the car to have been improperly adjusted by the last operator. Hence there is a great deal of useless and sometimes harmful tinkering with spark coils, gasoline feed, lubricator oil cups, etc. An emergency operator should be broken in, but the practice of allowing Tom, Dick and Harry to run the car should be stopped.

Keeping Cars Clean—There is one point which cannot be emphasized too strongly—*keep the cars clean.* This is one of the most important points in maintaining efficiency in this service, although it may not appear so.

A little time should be spent every day cleaning off the grease and dirt, and the car should be cleaned well at least once or twice a week, depending on its condition—once a week at the very least is necessary.

Inspection—A daily inspection of the car is also most important. This means tightening any screws or nuts that may have worked loose during the day's run. This

can be done at night or in the morning, but it should be done daily. It is very seldom necessary to take a car apart, but in such case it is preferable that an experienced man be called in to do the work, unless the operator understands the case thoroughly. When a car is in need of repairing, aside from the engine, it should not be run, but should be repaired, thereby avoiding accidents.

Filling the Tank—When filling the gasoline tank it is advisable to strain the gasoline through chamois skin. This draws out any water impurities that may be in the fuel. If the gasoline feed tube leaks, the car should not be used because the chances are it will catch fire.

The car should always be covered when not in use, giving it as much protection from the elements as possible. Oil and grease should be kept away from the insulated wires, for in time the oil will soak through and ruin the insulation.

Spark Plugs—When testing a spark plug, it should be held not more than about ¼ in. from the cylinder, otherwise the coil will be injured and possibly burnt out. Spark plugs seldom wear out; in case they are giving trouble, all that is usually needed is a thorough cleaning. It is not necessary to screw spark plugs in excessively tight; if this is done, they will expand so much that it will be almost impossible to get them out again. Porcelain plugs break very easily and must not be screwed up too tight.

Dry Cells—Sometimes in cold weather dry cells will freeze up. This does not mean that they are run down, but if thawed they will probably be found all right. When leaving a car the battery switch should be thrown off, and the gasoline valve closed. If the car is water-

cooled the water should be drawn from the radiator and cylinder in freezing weather; this prevents the cylinder from cracking.

Not to be Used for Recreation—The practice of allowing gasoline cars to be used for recreation, outside of working hours, should be discouraged, especially in the absence of the foreman. Indiscriminate use of motor cars is likely to result in accidents and loss of life, due to collisions with other small cars or with trains.

Rigid rules for the operation of all classes of power inspection and section cars should be formulated and enforced. Where practical, and especially with heavy cars or heavy loads, motor cars should be operated by train orders. If this is impractical, cars may be safely operated between trains, by keeping in close communication with train despatchers and telegraph operators. Flagging must be resorted to occasionally to fully protect the car; and when necessary, no hesitancy should be shown in stopping even the most important trains to prevent a collision.

Instructions—The man selected as operator should be furnished a complete set of instructions; and he should be a man who can absorb sufficient knowledge from printed and verbal instructions to enable him to thoroughly understand the principles of the generation of power, and the mechanical contrivances of the car. If the operator's knowledge consists of "advance timer lever and open the throttle," as is sometimes the case, failure is assured at the very outset.

With every make of car a list of "don't and do's" is furnished. It is well to read these carefully, for they usually represent the errors which inexperienced operators are most likely to make. Actual experience with

trouble, however, teaches the operator more than any printed matter, provided that he is able to ascertain the cause of the trouble, that he can repair or overcome the trouble, and that he can prevent similar trouble from recurring in the future.

Care in Operation—Hand in hand with good operation must go proper care, to insure success with motor cars. Bolts and nuts located on the moving parts particularly, and all parts subjected to constant jar and contact with oil, are likely to work loose. Therefore, daily inspection and occasional tightening is absolutely necessary. This is also true of the electrical connections. Proper lubrication is sometimes neglected in order to save time, but this frequently ends in a loss of time, due to the cylinder or cylinders running hot. With an air-cooled engine the matter of lubrication becomes vital, for a hot, dry cylinder means loss of power and permanent injury to both piston and cylinder, due to the friction, which is increased by the expansion of the piston from the heat generated. For this reason extra precautions should be taken to prevent a shortage or loss of lubricating oil when on the road away from a supply. This is the most frequent cause of needless injury to motor car engines. A good method of cooling an engine is to cut out the compression when running at a fair speed or down grade, and allow the plunging piston to draw in cold air and expel it with the following stroke after it has taken up heat. Lubricating oil may be mixed with the gasoline in the summer time, before it is placed in the gasoline tank, provided the oil is light and free from all foreign matter which might stop up the outlet. A lubricating oil can be obtained which actually unites with the gasoline. If this oil is well mixed with the

gasoline before placing it in the tank it will not settle and congeal, even in cold weather.

Exposure of cars to inclement weather, while not necessarily dangerous, should be avoided, particularly since a few square yards of heavy weather-proof covering. such as tarpaulin, will be sufficient to protect the car. Continued rain or snow, especially with a driving wind, is certain to cause trouble somewhere. Proper care of a motor car, however, does not consist entirely of prevention. When a car appears consistently to lack its usual power, it isn't a candidate for the junk pile, or necessarily a bad order case for the shop. A complete overhauling and cleaning is more often all that is required, and this can usually be done in a few hours' time by a man familiar with gasoline engines, with the ordinary available kit of tools and equipment.

Details of Motor Car Operation—Before starting a car the gasoline tank should be examined to see that there is sufficient fuel to run it to the destination. When the engine starts, the timer lever should be advanced slowly. The timer lever should always be carried ahead of the throttle lever when running. This not only saves the gasoline, but gets more power out of the car. Grease cups should be screwed up tight, and the car should be well oiled before starting. A car should not be run faster than twenty miles per hour. When running a car behind a train, it should run at least 1,000 feet in the rear.

The brakes should always be tested before starting. Grandstand stops should never be attempted as the brakes may fail. When approaching road crossings, the car should be run slow, with engine cut out, and always at such speed that the car may be stopped before run-

ning onto the crossing. It is advisable to have a bell to notify crossing watchmen of the approach of the car. When running at night a white light should be placed on the head end, and a red light on the rear end of the car.

When being overtaken by a following train, the car should be taken off the track at once. It is dangerous to try to keep the lead—the engine may fail and accidents result.

Starting Motor Cars in Cold Weather—It is harder to start motor cars in the winter because the gas is devaporized by the cold cylinder walls. With a water-cooled engine, boiling hot water may be put in the water jacket, a most effective way of rapidly heating the engine. The carburetor may be heated with a bag of warm sand or with warm water, but fire should not be used if some other method of heating can be employed.

A half thimble full of gasoline should be placed in each priming cup, which should then be closed. The carburetor should be flushed or flooded with the plunger, and the engine will then start if the crank shaft is revolved. The gasoline should be turned on, the switches closed and the throttle opened before starting the engine. Special gasoline of 62 to 64 degrees Baume should be purchased for priming purposes.

The preceding relates to starting 4-cycle engines. With a 2-cycle engine the lubricating oil can be warmed thoroughly, mixed with the gasoline, and then placed in the gas tank, thus warming the gasoline so that the engine can be started easily.

Water is likely to freeze in the low points of the carburetor or pipe connections and stop the flow of gasoline. To determine whether this has happened the carburetor

should be flooded, and if no gas is generated heat should be applied to the low point in the carburetor or the pipe, which is probably frozen.

If the car has a free-running engine it can be started in the section house. With a direct-connected engine the drive wheel should be lifted up and a box placed under one end of the car so that it can be started in the section house.

Causes of Trouble With Motor Cars—C. B. Skelton, motor car inspector on the Chicago, Milwaukee & St. Paul, gives the following suggestions for operation of motor cars:

"See that the working parts of engines are kept clean at all times, especially the timer, contact points, chains, spark plugs, valves and piston rings. The latter may be easily cleaned by using kerosene in the engine. In addition, see that all wires are fastened securely at the terminals and that insulation is in good shape.

"A great many times a foreman will have the spark plugs cleaned and will not test them before having them replaced in the cylinders. This should always be done.

"If a spark is not perceptible something is wrong; the plug is grounded either through the porcelain member or through the insulation. Possibly the current is jumping through the wiring at some point and not reaching the plug. In a case of this kind another plug should be tried, to make sure just where the trouble lies.

"Spark coil boxes should be protected from rain and snow by covering the box with oil cloth or with some other covering that will keep the moisture out.

"Spark coils are often damaged by connecting up too many batteries to the coil. Most coils are built for 6 volts on the battery circuit, or the equivalent of 4 cells

when batteries are new; if more batteries are added the voltage runs over 6 volts, not only wearing out the vibrator points very rapidly, but very often burning the coil insulation, putting it out of service.

"When coils become worn out or it is found that they do not work properly, the foremen should not undertake to make the repairs themselves, as the instruments are very delicate, but should send the coils to the general storekeeper under registered baggage for repairs; and in each case the roadmaster should make requisition for the repairs and show the registered tag number on the requisition.

"Carburetors should also be handled in this way and should never be shipped to the general storekeeper by freight, for these parts cost considerable money and are often lost or stolen when shipped in this way. Under no circumstances should foremen keep extra spark coils or carburetors in tool houses for emergencies, but on receipt of a new carburetor coil should immediately ship the old one to the general storekeeper under registered baggage and advise him so that he will know who it is from.

"When it is found necessary to order new parts for motor cars, the foreman should first go through his catalogue and obtain the correct symbol number of the part he desires, then advise the roadmaster of the part number of the motor car. If the foremen will follow these instructions, it will save the storekeeper and others a great deal of trouble and will eliminate a great many delays which are caused by the wrong part being ordered."

CHAPTER III.

SPIKING, CUTTING AND CURVING RAILS, ETC.

Spiking—A foreman can obtain good spiking only by very careful supervision and training of the men. Spikes should always be driven perpendicular to the face of the tie. If driven slanting, their holding power is decreased and they are difficult to pull with a claw bar. Spikes should be driven down so as to give the head a firm hold on the rail, but should not be struck after being snug,

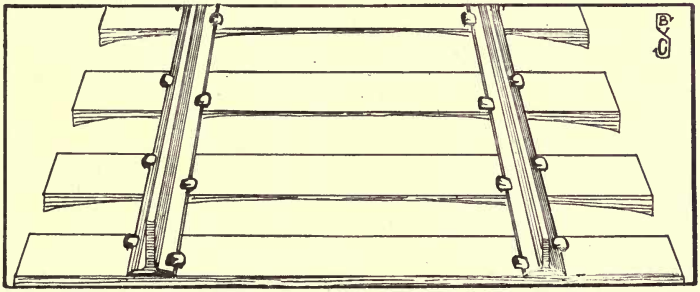

Fig. 4—Correct Position of Spikes on Ties.

as they are likely to crack under the spike head. The spikes should be staggered—those on the outsides of the rails should be near the same edge of the tie, and those on the insides of the rails should be on the opposite edge of the tie. This will keep ties from slewing around or rocking. The usual practice is to place spikes at least 2¼ in. from the edge of hewn or sawed ties, and one-fourth of the width of the face from the edge of pole ties. On curves, the best practice is to double-spike the

outsides of the rails, using tie plates with two holes in each side.

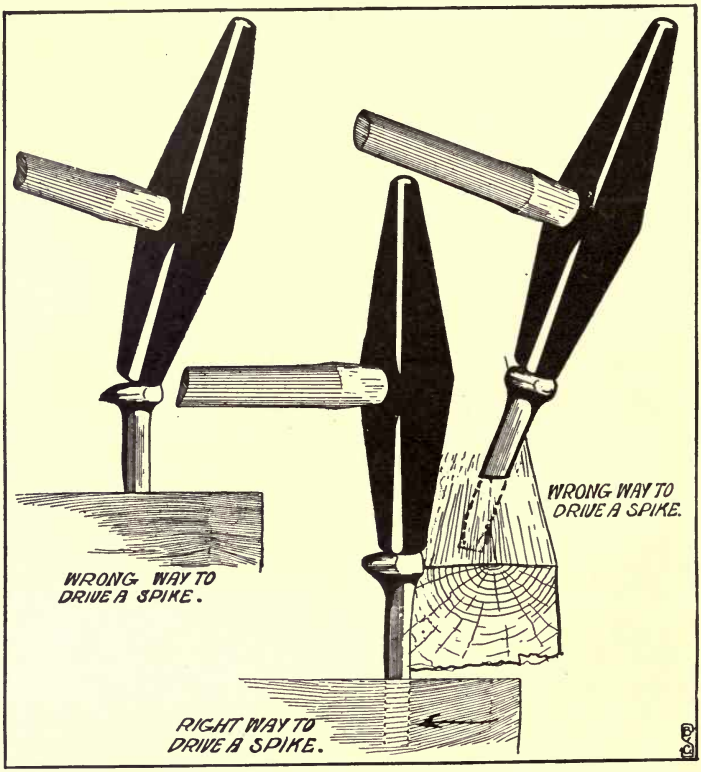

Fig. 5—Correct Way to Drive Spikes.

Whipping Spikes—The practice of "whipping spikes," that is, bending them toward the spiker, is to be severely condemned. Drawing the rail in when driving the spikes should never be allowed except in places where it is ab-

solutely impossible to force the rail in against the gage with a bar.

Gage Spikers—When spiking, the tie is held up against the rail by the nipper with a pinch bar and block, or with one of the various types of holding-up bars. Much depends on having the gage uniformly correct and the gage spikes driven straight and accurately. When line spiking, the line rail should be kept as nearly as possible to the correct line.

Expansion—The importance of providing correct expansion when laying rails, cannot be overestimated. If the track is laid too tight, sun kinks will result, particularly if there is an insufficient amount of ballast. If there is plenty of ballast, tight track may be kept from kinking to any appreciable amount, but it will frequently show small kinks at joints and the track will appear to be in imperfect line. It is impossible to surface track or line it if it is too tight, for no sooner is the track loosened than it kicks out and it is then almost impossible to get it back onto the grade where it belongs. It is also extremely difficult to make any changes in such a track; for instance, to put in a switch or to put in insulated joints, which require an extra half-inch space for the end posts. In very tight track it is usually advisable to wait until after a switch has all been put in, to measure and cut the pieces back of the frog. The amount of expansion required has been reduced greatly with the advent of heavy section rails.

Loose expansion is likely to cause the rails to pull apart in the winter time, leaving a joint so wide open so that it may cause a wreck, and even in the summer time the joints will be so wide open that the rails will

be battered and spoiled and almost impossible to keep up to surface.

Cutting Rails—An excellent method of cutting rails is as follows: Chisel mark the rail to a depth of about ⅛ in. on both sides of the web and base (not the ball) with a sharp track chisel. Turn the rail on its side and spring down with bars or by having men stand on it and in the meantime place a chisel on the rail above the cut and strike it with a heavy hammer until a small crack appears in the cut. The rail should then be turned over on its other side and the operation repeated. Finally the rail may be turned ball up and a heavy blow

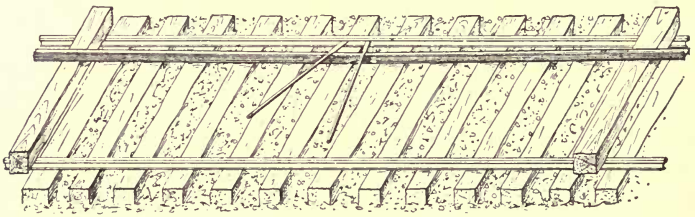

Fig. 6—Easy and Quick Way of Breaking Rail.

struck on an old chisel held above the cut, with the men standing on the rail; one blow will usually be enough. The chisel should be held directly above the cut and then a clean, straight break will be made. The chisel cuts should all lie in a plane perpendicular to the axis of the rail, and the cutting chisel should be struck only light square blows or the edge may be broken or chipped.

A fairly good cut can be made as follows: (See Fig. 6.) Cut the top of the base of the rail on one side, deeply from edge to web, with a sharp chisel. Turn the rail on its side with the cut down, next to a rail on the track and with ends resting on blocks. Four men with

bars obtain a leverage under the ball of the rail, and bear heavily on it while a man strikes a blow on the chisel held on the base of the rail above the cut. When the rail cracks in the cut, it is turned on the opposite side and the operation repeated. The rail is then turned ball up and one sharp blow on the chisel held over the cut will usually break it.

Rails cut in the first way mentioned often show a smoothness of face rivaling that of a sawed rail. An older method of breaking a rail was to chisel mark the ball in addition to the web and flange. A short piece of rail or "dutchman" was placed under the cut, one end of the rail was lifted high off the ground by a number of men, and allowed to drop. The last method has the following disadvantages: (a) It exposes men to the danger of being caught under the falling rail and injured; (b) it requires more cutting and therefore more time; (c) it requires more men; (d) it does not produce as clean a break. The ease with which a rail breaks depends not so much on the depth as on the straightness and sharpness of the grooves cut in it. If the rail is hot the process of cracking may be facilitated by chilling it with cold water at the point where the rail is chisel marked.

The use of hack saws for cutting rails is becoming common. Several hack-saw machines are on the market, which eliminate the disadvantages of the old hack saw, that is, breaking of blades, slow progress, poor cuts, and back-breaking work. The Schmidt hack saw, it is claimed, will cut an average weight rail in about 40 minutes. The tool is handled by one man and the labor cost is not any more and probably less than cutting a rail with a chisel, which takes at least two men. Particularly

with a poor class of labor there is a great advantage in using one of these machines.

Cutting off Short Pieces of Rail.—For cutting a short piece, say 6 ins., off the end, the rail should be marked as described above. It should then be turned ball down, the chisel placed in the cut in the base directly above the web and the cutting continued until the rail finally breaks. Or one of the new type rail benders may be used to break the short piece off.

Mr. F. B. Freeman, chief engineer of the Boston & Albany, has very kindly given me the following information on methods used in cutting rails on their road. (1) By using a 12-in. hand hack saw, it requiring about 1 hour to saw a 95 or 105-lb. rail; (2) by the use of a Schmidt rail saw, this method being very satisfactory. A piece can be cut from a 105-lb. rail in approximately 45 minutes; (3) by the use of the Samson rail bender, with which short pieces down to 9 in. can be cut off. The rail is marked around with a chisel and then broken off by placing the rail bender upon it and tightening up with the wrench. The break is not always even or satisfactory, however, using this method; (4) by the use of the Sherburne rail bender by which a piece as short as 18 in. can be cut from the end of the rail after first marking with the chisel. A shorter piece can be taken off by bolting two rails together, but this method is seldom satisfactory; (5) by the use of a sledge hammer, cutting the rail all around fully and deeply with a chisel. Place the rail on a solid foundation and strike the end with a hammer. Rails of 80-lb. sections or less can be broken off satisfactorily in this way, but larger rails not so satisfactorily.

"To summarize, the satisfactory methods take too long

a time, and the quicker methods do not give an even break. What we really want is some kind of a small oxy-acetylene outfit, which would make a clean cut in a few minutes without damaging the end of the rail or injuring the men.

*Simple Method of Cutting Rail.—The cutting of rails by means of hacksaws or rail saws or by chiseling and dropping is tedious and slow as compared with the following method of breaking the rail in the track. With no other tools required than those carried by a section crew, several men can neatly break a rail of any weight in a few minutes.

Remove the spikes from the short end of the rail, or the pieces to be cut off. On the outside of the rail, chisel a line about $\frac{1}{16}$ in. deep from the edge of the base to the top of the head. Bend the end of the rail over as far as possible by the use of bars, and at the same time place a track chisel on the inner side of the web and near the base, on the line of the desired cut, and give it a hard blow with a heavy sledge, as pressure is exerted on the end of the rail. Nine times out of ten the rail will snap apart without a second trial, making a clean-cut break. If a very neat break is desired saw a line about $\frac{1}{16}$ in. deep across the head. Lengths as short as 12 in. can be removed providing another rail is attached to make it possible to exert the necessary pressure.

Geo. E. Tonney.

Bridge Engineer C. A. Smith Timber Company. Myrtle Point, Ore.

Curving Rails.—The American Railway Engineering Association recommends that rails should be curved for

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*From Engineering Record.

all curves of two degrees or over. The natural tendency of a rail is to lie straight and that is the reason that most track men believe in laying curved tracks with broken joints, for then the centers tend to move inward and this tendency is resisted by the joints opposite, which tend to move outward on the curve.

Although the A. R. E. A. recommends curving for two degrees or over, the general practice is not to curve under six degrees. The Pennsylvania R. R. does not curve any mail-line rails and only those for the sharpest curves on sidings.

Rail Benders—The roller rail bender is generally used for curving rails. A common type of bender consists of two rollers which are placed on one side of the rail and a third roller which is placed on the opposite side. The third roller can be adjusted by means of a screw to give the rail the proper curvature. The roller rail bender can either be arranged to move along the rail or can be fixed at a certain point and the rail moved through the bender.

Putting a Stock in Rails—There are a number of types of rail-benders on the market for putting the kink or stock in the stock rail of a switch, the jim crow being the type most commonly used. This consists of a U-shaped forging with a screw shaft about 3 in. in diameter operating through threads in a nut which bears against the middle of the U forging. The head of the screw shaft sets against one side of the rail head and the ends of the U-forging hook over on the opposite side, so when the screw is tightened it produces a kink in the rail between the two hooks.

A newer type of rail bender consists of a casting about 3 or 4 ft. long, with a screw shaft in one end, and a hook

in the middle which clamps over ball of rail. When the screw is tightened the opposite end of the casting presses against the rail, while the hook at the center forces the rail in the opposite direction, thus kinking the rail at the clamp.

Superelevation on Curves—Opinions on the subject of superelevation have changed materially in the last few years. It is not customary now to give as much elevation on curves as formerly and in fact many engineers are inclined to think that on low-degree curves, level track would not be dangerous. For higher degrees, however, elevation should be provided, but too much elevation should not be allowed any more than too little. The engineers should specify the elevation and

Fig. 7—Saw-Tooth Method of Elevating Outer Rail on Curves.

this information should be put on the stakes at the points of curves.

Excessive elevation is a constant source of trouble while too little elevation makes dangerous track. In yards and on sidings it is not necessary to provide elevation unless these tracks are used by high speed trains. On single track the elevation is usually made by elevating the outer rail, leaving the inner rail at grade. This makes the subsequent maintenance or resurfacing of the tracks easy, while if the inner rail is depressed it would be difficult to resurface the track if the grade stakes were lost. ("Simplified Curve and Switch Work," by W. F. Rench gives in detail, practical methods of spiraling, lining and elevating curves correctly.)

Curve Elevation on Double Track—Curve elevation

on double track may be handled in three different ways. The sawtooth method is where the corresponding rails of both tracks are at the same elevation, as shown in Fig. 7, this necessitates extra provision for drainage at the inner rail of the outer track, and this arrangement also makes it difficult to put in crossovers. The "step method." Fig. 7-a is where the outer rail of the inside track and the inner rail of the outside track are placed at the same elevation, usually on grade, and the superelevation is obtained by depressing the inner rail of the inside track and raising the outer rail of the outside track. It is difficult to put in crossovers on curves elevated by this method. If crossovers are to be put

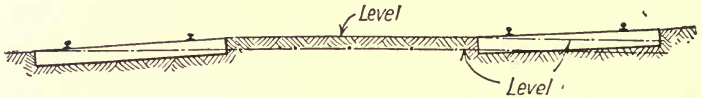

Fig. 7a—Step Method of Elevating Outer Rail on Curves.

in, the plane method of superelevation, Fig. 7-b, is the best one to use. All the rails are placed in the same slanting plane, which requires raising the grade of the outer tracks considerably. This is objectionable since this raise in grade must be run out at the ends of the curve. On three- or four-track lines, the plane method would require too much change in grade to be adaptable. The "step" method does not require cross drains and is perhaps the most suitable for double track in general.

Widening of Gage—As in curve elevation, opinions regarding the widening of gage on curves have changed radically in the last few years. Many engineers are not widening the gage on curves of less than ten degrees. Wide gage is likely to cause excessive wear on the rails. A table is given in the Appendix showing the amount of gage widening which the American Railway Engineering

Association recommends for curves of different degrees.

Tie Plates—It was formerly the practice to use rail braces where the track was likely to spread. This practice is being rapidly discontinued except on switches or on sharp curves such as are found in large terminals. Properly designed tie plates have been found to hold the track to gage on curves better than rail braces. They require fewer spikes, and also protect the ties from mechanical wear and from spike killing. Those plates which have deep projections embedded into the tie hold the track best on curves, although it has been claimed that long flanges or prongs injure the tie and allow moisture to enter, and decay to start. Even with flat bottom-

Fig. 7b—Plane Method of Elevating Outer Rail on Curves.

ed plates, the resistance to widening of gage is more than double that of a single spike, as the plate cannot move without cutting into or bending both the inside and outside spikes.

To develop the value of rail braces it is necessary to put one on each tie against the outside of each rail. A brace on but one side of a tie is sometimes useless if the tie moves easily in the ballast, allowing all of the strain to come on the single outside spike on the opposite end of the tie. Tie plates of course should also be put under both rails on the same tie in order to obtain the maximum gage-holding power.

CHAPTER IV.

CONSTRUCTING TRACK ON A NEW LINE.

Material Yard—A well laid out and carefully operated material yard in charge of an experienced track foreman is a great factor in rapid and economical track-laying. The loading of the proper materials on the swing train which supplies the construction train at the front, is of the greatest importance. The man in charge of the material yard should have had previous experience in track laying, otherwise he will not always realize the exact materials or amount of materials that are needed at the various points along the line. By study of the profiles and maps, an experienced man can arrange the special material, such as curved rails, switches, etc., on the swing trains so as to have them come exactly where they are needed.

It is of the utmost importance that the material yard for the construction of a long line be located so as to facilitate unloading and loading. Several material yards may be needed in order to carry on the work in the best manner and the various yards should be laid out in advance so as to best fit the needs of the sections each is to supply.

The following points should be considered in laying out a material yard: (1) The amount of main line track for which material must be handled; (2) the speed of track laying desired; (3) the number of cars to be handled daily—both those going to the front and those coming in to keep up the supply in the material yard. Much depends on the location and nature of the ground. The

location should preferably be on ground with good natural drainage. A location should be chosen where very little grading will be necessary. Small ditches should be dug at the ends of the ties to provide track drainage and the material dug out can be thrown in the middle of the track and used to bring up the short sags or low spots. There is little objection to the track running over little raises of ground and no great amount of work should be spent in surfacing. In general it will be found best to locate the yards so that the switches for entering and leaving are at the end opposite to the direction of track laying. At least one track should be connected at both ends with the main line. The dirt from the drainage ditches can be used to surface the track sufficiently to prevent surface bending the rails. The track should be of a temporary character using only about 12 ties per rail length unless the rail is very light weight.

Arrangement of Yard—The exact disposition of the material in the yard is governed largely by the local conditions and methods of track laying to be used. To avoid delay in loading, a systematic order should be preserved so that materials which are to be used simultaneously on the work will not be widely separated in the yard. For instance, rails and rail fastenings should be piled close together for if the cars of rails are to be "trimmed" the fastenings should be placed so as to be accessible when the train is pulled ahead after loading instead of having to back up or back in on another track. In unloading materials when stocking the yard, much can be done toward aiding quick loading of the swing train by careful placing and piling.

Alleys 5 ft. wide should be left between every alternate pile of ties to provide room for water barrels for fire

protection. A 3-ft. alley will be sufficient between all other piles. The ties may be stacked 25 high at the end where racked up, sloping the pile toward the car to give a footing for the men unloading and piling.

The foundation for a pile of rails should be solid enough to prevent the pile from sagging and bending the stringer or skid rails. The piles of rails should be as wide as the standard rail length used, so that full length rails may be used for stringers or skids. It is perhaps unnecessary to say that rails should be handled with a derrick, both in unloading and loading.

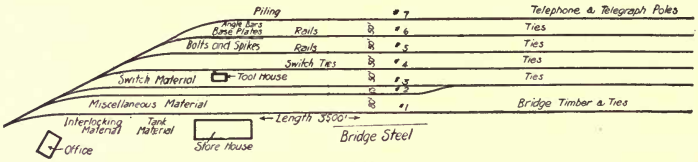

Fig. 8—Plan of Material Yard.

Angle bars, spikes, bolts, etc., should be placed on a cribwork of ties with a floor of ties or plank about 2 ft. above the track. This arrangement will prevent the rapid rusting which is likely to occur if this material is placed on the ground, and the kegs of spikes and bolts are not likely to be broken in handling. This arrangement also greatly facilitates the reloading of this material on the swing train. Track fastenings should be placed at the down-grade end of the rail pile, if the yard is on a grade, to facilitate the moving of cars by the use of pinch bars, when loaded with rail and ready to be trimmed.

The suggested material yard layout, Fig. 8, will afford place for rails, ties, spikes, bolts, angle bars, switch material, crossing plank, piling, bridge timber, steel gir-

ders, truss spans, tank material, telegraph and telephone poles and all miscellaneous material necessary for the construction of 100 miles of road through a prairie country. The plan can be further developed by the addition of a ladder track at the end of the stubs, or it may be curtailed by reducing the length of the yard. If the full ladder is not used, at least one track, preferably No. 3, should be connected with the main line at both ends. The idea of connecting track No. 2 with No. 3 is to provide a run-around track. The centers between tracks are only 13 ft., affording a good opportunity for transferring material from one car to another if occasion arises.

Passing Tracks—In order to keep supplies near the front it is always well to build side tracks at intervals as the work advances, for use in passing trains and also for the use of the outfit cars. On pages 132, 133, 134 and 135 are outlined methods of building such side-track turnouts without using either frog or switch points. These turnouts are not only very easy to install and require practically no switch material, but are safer and more easily taken up than permanent turnouts.

Boarding Camp—A boarding camp should be provided when laying track on a new line as the boarding accommodations are bound to be very poor or entirely lacking. Bunk cars should be provided in such numbers that it will not be necessary for more than 8 or at the most 12 men to sleep in one car and steel bunks should be provided, as well as other appliances for the comfort and convenience of the men. A roomy kitchen car should be provided and enough dining cars to seat comfortably the largest number of men which is likely to be employed on the work. A tool car, office and supply

car, fuel car and tank car are usually needed to make the outfit complete. A special car for blacksmith work, or a small portable forge outfit should be provided, which can be kept in the tool or supply car. The tool car should have both side and end doors.

When moving the camp to the front, the outfit cars should be placed at the head of the construction train and extreme care should be taken to prevent any unnecessary shocks, which will result in breaking dishes, etc., and a general shaking up of the entire outfit.

When the side track nearest the front is reached, the outfit cars should be set out, and the work train should proceed to the front with the track material which was brought in the same train. The boarding camp should be kept as near the work as possible—laying temporary turnouts or spurring the cars out without using switches —in order that it will not be necessary to ride a long distance to meals.

Material Trains—The construction train usually carries enough material for a half day's work; 15 cars can usually carry enough for one mile of track, including 5 cars of rails and fastenings, 8 cars of ties, and one car of miscellaneous material such as crossing plank, cattle guards, etc. Swing trains are required after the work has progressed far enough from the material yards to make the run too long for the construction train. The swing train runs the loaded cars in on the siding, where the construction train crew picks them up. The swing train then picks up the empties previously left on the main line by the construction train, and returns to the material yard.

The above discussion assumes that the bridges and trestles have been built before tracklaying begins. Large

bridges, in any case, are built as the work progresses and the construction train hauls the bridge material to the site.

Methods of Track Laying—In building a new line the material must be forwarded over the track which is under construction. There are four general methods which may be used in constructing a new track, viz.; (1) An ordinary dumpy handled by the men; (2) rail car, and wagons with teams to distribute ties on the grade; (3) an ordinary flat car and rail dollies, with teams to haul and distribute ties; (4) a track-laying machine.

(1) Laying Track with a Rail Car—When it is only necessary to lay a short piece of track, say less than a mile, an iron car may not be available, in which case an ordinary dump car must be used. When carrying both ties and rails, just enough ties should be taken in a load to quarter or third tie the track. Eight or ten rails can be carried, and they should be placed 4 or 5 on each side of the car as near the edge as possible. The ties should be loaded on top of the rails, and the car pushed ahead by the men.

When the car reaches the front, the laborers should first distribute all the ties ahead, spacing them by eye. It is better to make the spacing for the first rails rather wide, so that there will be plenty of ties to reach as far as the rails will extend. Angle bars, spikes, and bolts, in sufficient quantity, can be carried in the middle of the dumpy between the rails. The angle bars are hung and the rails heeled in when set up. If the footing is good, the rail gang should pick up the rail bodily, step back from the ties, and carry it ahead. In general, spiking is not necessary ahead of the car, the rail laying gage at the end being sufficient to hold the track for the

passage of the car. The spikers should, however, follow the car as closely as possible so that there will be no derailments on the return trip.

(2) Use of Rail Car, With Teams Hauling Ties—The method of carrying both ties and rails on the steel car is seldom used where continuous track laying is in progress, it being quicker and cheaper to distribute the ties by teams. Good judgment is required when distributing ties in this manner. To unload the ties in such quantities that the teams can get them to place on the grade with the shortest possible haul requires careful planning and ceaseless supervision. Many problems are caused by rough country, streams, etc. The wagon boxes are usually removed and the ties loaded directly on the wagon sills. This places the load lower, lessens the likelihood of tipping, and makes it possible to turn the empty wagon around on a very narrow grade. Difficulties are caused by long high fills and deep narrow cuts. All these conditions must be met by the foreman by building temporary tie bridges over streams or gullies, by making detours, and in some cases by only partially tieing ahead and full tieing after the track has been laid. On long high fills or in narrow cuts, the ties may be unloaded and piled lengthwise along the sides, leaving the center for the use of teams; or the ties may be distributed and spaced across the grade beginning at the far end of the cut or embankment.

The rail car should be light and strong, and have wide flanged wheels. Two or three rail cars must be used where rushing the work, the loaded cars passing the empties by tipping the latter up on edge at one side of the track. A temporary portable turntable has also been used for passing rail cars.

The steel gang should always be kept at the front in order that the work may proceed rapidly; if two or more cars are used these men should not have to do more than push the empty car back a short distance to meet the loaded one. As very few spiked ties are required to hold the track to gage for a rail car, the use of bridle rods is hardly justified.

(3) Use of Engine and Flat Car With Tie Teams—This method is not generally used where there is a long stretch of track to lay, but with a good organization, rapid progress can be made in laying short stretches of track. The ties are distributed by teams as in the method mentioned above.

Two flat cars of rails may be taken out at one time, if a half dozen rail dollies are available. The rail is picked up and placed on the dollies, one of which is at the head end of the car, and the rail is run ahead. The steel gang grabs the rail as it runs forward, and walks ahead, the heelers taking the end of the rail as it leaves the car. The rail is then heeled in. When all the rails on the first car have been laid, the dollies are placed in a line on the empty car, with several on the loaded car, and the rails are dollied across the empty car. Consequently more men are required when working from the second car.

The strap hangers, spikers, and the rest of the gang are organized the same as for a track laying machine (described below), or a rail car.

Hurley Track Layer.—The Hurley Track Laying Machine is made up as follows: The pioneer car, 8 cars of ties, and 4 or 5 cars of steel. The power for moving the train is furnished by the machine itself, no locomotive being required during the process of laying track.

One of the engines on the pioneer car is connected by gears to the axles, the engine being low geared, and the machine keeps up a steady movement without stopping, as long as the rails are being laid. The speed of the machine is adjusted to keep pace with the men, or rather it sets the pace for the men.

Dead rollers are placed on the car floor on each side,

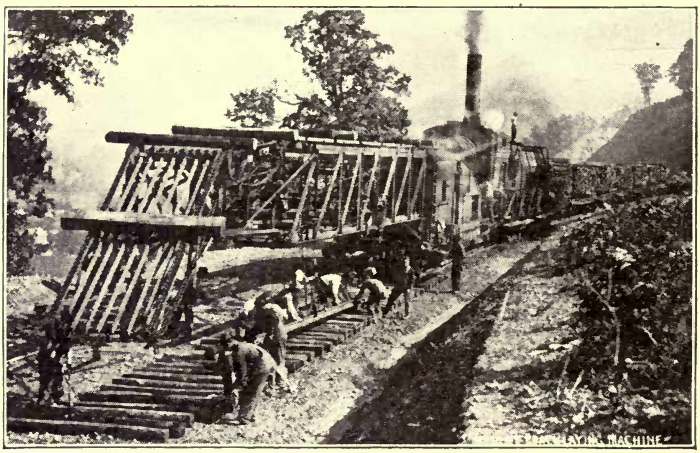

Fig. 9—Hurley Track Laying Machine.

the ties being piled on longitudinal stringers, 7 or 8 in. above the floor, leaving space for the rails to pass under them. When starting on a new train load of material, rails from the first car are rolled into the rollers one at a time. The first rail is shoved ahead or pulled ahead by cables, a second rail is placed on the rollers, and the angle bars are put on loosely with one bolt in each rail. The two rails are then pulled ahead, a third one bolted up, etc., until the string of rails reaches the pioneer

car. Here the rails are run between two compression rollers, operated by the engine, which pull the two strings of rails ahead. The rail men supply rails constantly. Angle bars and bolts are loaded on the ends of each car of rails.

The ties are rolled down onto the rail, starting with the car immediately behind the engine, the ties being spaced by eye. Thus the rails provide the means for moving material to the front, including ties, angle bars, bolts and nut locks.

The ties are carried along by the rails until the pioneer car is reached; here they are caught by an endless chain and conveyed up over the top of the trusses (which project 40 to 45 ft.). The ties are dropped in place one by one on the subgrade ahead of the rails. At the front of the machine the rails are uncoupled, leaving a pair of splices at the head end of each. The rails are then gripped near the middle by a pair of tongs, lowered to the ties by steam hoists, and heeled into place by 2 or 3 men. The bottom of the trusses is 8 ft. above the grade. The track is usually held to gage by bridle rods until the machine passes, and all spiking is done in the rear. The flat cars must be prepared for use by placing rollers at each corner.

The material train changes the empty cars out for a new train during the dinner hour. The machine being geared low, does not start hard or become stalled as easily as if dependent on locomotive power, but a locomotive is necessary on very steep grades. The organization of the force ahead and on the machine is about as follows:

8 men connecting rails on the rear car.
7 men on the tie car rolling the ties onto the moving rails (includes the tie fiddler).
2 men at the rear of the machine keeping ties straight as they start up the incline.
1 man inside of the machine taking the bolts out of the angle bars.
1 man on the platform in the truss applying tongs to the rails.
2 strappers.
1 heeler.
1 man with a bar throwing the rails to line.
1 man taking the tongs off the rails.
5 bridle-rod men.
2 men spacing the ties in front of the machine.
1 man ahead of the machine with the tie line.

32 laborers.
1 assistant foreman.
1 foreman.

The tie men ahead of the machine use tie tongs to line and space the ties, which require but little moving after being dropped on the grade. The rails are lifted onto the dollies by a small hand-power crane which is set up in the stake pockets; this hoist is operated by two men, the rails being dropped on the dollies without any lifting by hand.

The Roberts Machine—The following description of a Roberts track laying machine, written by Charles L. Van Auken, applies when carrying material for one mile of track.

The train carrying the machine is made up as follows, beginning with the "pioneer car," which always remains at the front. Immediately behind that are 5 cars of rails, then the locomotive, 8 cars of ties, a car of tie plates when they are used, the "trailer," which is a car carrying spike, bolts and base plates, a car of plank for crossings, a car of cattle guards, a tool car and a way car. This makes 20 cars and all are flats except the two last mentioned. (SEE Fig. 10.)

The first car of rail behind the pioneer is "trimmed," loaded with angle bars enough to lay the amount of steel carried on the train. The angle bars are carried forward over the pioneer car and delivered as needed to the "strap hangers" in front. The rails beneath the angle bars are the last ones laid from the train; the angle bars will, therefore, be cleaned off by the time these rails are needed. The car next to the locomotive carries short lengths of rail, used to prevent joints from coming close to ends of bridges, etc.

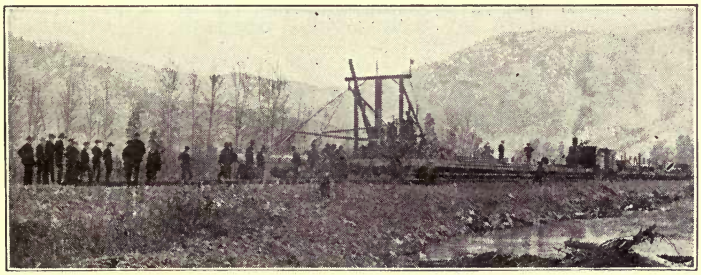

Fig. 10—Roberts Track Laying Machine.

A system of trams, one on each side of the train, is used to carry the ties and rails to the front. The trams are made in sections, each 33 ft. long, the sides consisting of 2½x10 in. planks. The tie trams are 14 in. wide, and rail trams are 12 in. wide, and they are held together by bolts on which are pipe separators. Near the bottom are live rollers, which complete trough-shaped ways for ties and rails.

A 20-hp. upright engine, installed on the pioneer car, drives the live rollers in the trams by means of a tumbling shaft and gear or cog wheels. Steam for the stationary engine is piped from the locomotive. The shaft is fitted

with "patent couplings," on one end of each section of which there is a casting containing a square socket into which the end of the next rod fits. Each length has a section of the shaft bolted to it, and as the trams are hung the rods are fitted together, thus forming a continuous shaft. The trams are "hung" on iron brackets or trusses which hook into the stake pockets on the cars. The trusses on which the trams are placed are made with flanged rollers, thus taking care of the slack of the train in starting and stopping. The trams have a coupling device which holds them together, the ones on the pioneer being permanently fastened.

The tie trams, 660 ft. long, are operated on the right side of the train, while those for the rail, 240 ft. long, are on the left. The movement of the ties and rails is controlled by the "dinky skinner," i. e. the stationary engineer, so as to deliver them in front of the train as needed. A tie chute 53 ft. long provided with dead rollers is attached at the front end of the tram on the pioneer, and through this chute the ties are pushed by the ones coming forward over the live rollers. As fast as they are delivered at the end of the chute they are taken by the "tie buckers" and placed across the grade ready for the rails.

A similar chute attached to the rail tram provides a way for delivering the rails in front of the pioneer. These chutes are supported at the outer ends by cables attached to the rear end of the pioneer car, and carried up over a high frame work or "gallows" at the front end. A boom, also attached to the front end of the pioneer car, extends far enough ahead to have the cable attached to it reach the middle of the rail when placing it in position in the track. This cable is operated by hand

with an ordinary crab. Instead of cranks, a small light buggy wheel is used by the operator to wind up the cable, which lifts the rail and holds it while the "heeler" and his assistants place it in position. (A newer device handles the cable with compressed air.) The rails are placed in the trams by three men, and are handled in front by four men. One man on each car places the ties in the trams. The spikes, bolts and base plates are peddled from the trailer as the train proceeds.

The rails are held to gage by bridle rods until the train passes over, all spiking being done in the rear. The train moves ahead one rail length at a time, when laying square joints, and half a rail length when laying broken joints. The trams are taken down when the cars are empty and replaced on the loaded cars when a new train arrives; 100 to 125 men are required for a full crew. Under ordinary conditions a mile of track is laid in from three to four hours. The force ahead and on the machine is organized about as follows:

ORGANIZATION OF FORCES.

Tie buckers	10	Angle bar peddler	1
Tie spacers	2	Bolt peddler	1
Tie fiddler	1	Rail men on cars	6
Rail buckers	8	Tie men on cars	6
Strappers	2	Bridle man	1
Bridle men	2		—
Line man	1		42
Tie line man	1		

The force back of the machine is organized as spikers and bolters. Track must be kept one-third to one-quarter spiked, close up to the machine, to provide for the return of the empty train. One locomotive is required with the machine, and sometimes more than one on ascending grades.

Cost of Track Laying with a Roberts Machine—The

author and Charles L. Van Auken contributed an article to Engineering and Contracting giving the cost of laying 42 miles of track during 1913, from which the following is extracted:

TABULATION OF COSTS.

Overhead charge on machine (interest at 6%, depreciation at 10%) estimated	$ 100.00
Dinky skinner, 2 1/6 months at $100	210.00
Timekeeper, 2 1/6 months at $85	177.00
Locomotive and crew, 65 days at $40	2,600.00
Supervision and labor	8,710.00
Gross total	$11,797.00
Force account, or extras allowed	280.50
Net total	$11,516.50
Average net cost per mile	271.64

The rail used was 33 ft., 90 lb. rail laid square joints on tangents and broken joints on curves. When a curve was reached a rail was cut to break the joints, the cut being figured so that if the short part was used on the inside of the curve at the start, the long part would square up joints when used at the point of tangent on the outside rail of the curve. The specifications stipulated that joints must not be laid within 4 ft. of the ends of bridges and culverts. To avoid cutting rails to meet this condition, fractional steel (short rails) was loaded on the "trimmed" car and when approaching a bridge the distance was measured, and if found necessary a panel or more of short length rails was used to bring the joints the desired distance from the end of the bridge. In laying through yards where sidings were located, the main line was laid through regardless of the switches, and when the switches were put in, they were laid as near to the engineer's location as possible without cutting the main line rail. The fractional steel, a certain amount of which is sent with every large order for rail, was laid

between the switches on the main lines through the station grounds. As a rule the sidings were all laid with relieved rail, the work being done by hand.

The rail was laid on white oak ties, spaced 18 to 21 under a 33 ft. rail on tangent, and 19 to 22 per 33 ft. on curves. The joints were ordinary four-bolt angle bars with spring nut locks. The heads of the bolts were staggered, i. e., bolts were put in with the heads alternately on the inside and outside of the rail. The number of ties per rail length was varied, 18 broad-faced ties being used, or 21 narrow-faced ties, on tangents.

The scarcity of costs on track laying make definite comparisons impossible. The cost of laying track, with an iron car on the Erie R. R., in 1905 and 1906, was published in an article by H. C. Landon, in the Erie R. R. Employes Magazine. The cost was said to be $200 per mile. The cost of labor and supervision was as follows, for a gang of 60 men:

1 foreman at, per day	$ 4.00
2 assistant foremen at, per day	3.00
Locomotive and crew at, per day	40.00
61 men at, per day	1.50
1 water boy at, per day	1.25

The average cost of labor in the 1913 work described herein was 58% above that of the 1905 work; while the cost of track laying in the 1913 work was only 40% above that given for 1905. It is probable that the steel laid in 1905 was a much smaller section, and that soft ties spaced at wider intervals were used. It is safe to say that with the present average of railway company labor, it would be impossible to lay track for less than $350 per mile, and the cost is at least $400 in most cases.

The Harris Track Layer—The Harris Track Layer consists of a narrow-gage track in the middle of the flat

cars on which the rails are loaded. This track rests on timbers about 7 ft. apart, with a rollway between for transporting the track rails to the pioneer car. The ties are run out to the front on a tram car. Short sections of rails, fitted at the end with self locking clamps, are used between flat cars. These rails are dropped in place when ready to lay track.

The rail cars are placed next to the pioneer car, and rails are loaded in two piles, one on each side of the car just outside the narrow-gage track. The track and rail dollies extend about 20 ft. ahead of the pioneer car, being supported by cables running over a gallows frame near the front of the car. The cross stringers protrude a foot or so over the edge of the cars, and support a plank runway on either side, which is clear of all material, and which is provided for the men loading ties and for the men pushing the tie car.

The narrow-gage tie car used to move the ties ahead has high wheels with the car frame also mounted high so that the ties will clear the rails which are piled on either side. A tie loading trestle is used upon which the ties are loaded while the tie car is being pushed ahead with a load. The car when brought back empty is run under the tie loading trestle, and the car automatically trips the load onto the car frame, and the men then start forward again.

The tram-car body is built in two parts, the upper sliding on the lower. On reaching the end of the track the car runs against a timber stop, the upper frame slides forward on the lower for a distance of about 30 in., thus overbalancing the load, tipping the frame forward, and dropping the ties across the road bed. A "trestle dolly" mounted on a frame work about 4 ft. high, is used

ahead of the machine to roll the rails forward on after they leave the pioneer car.

Four men load the tie loader, and 3 or 4 men push the car. The usual method is to have the same men at the front distribute both rails and ties. A locomotive moves the machine ahead after each rail (or pair of rails) has been set up. The other work and organization around the machine is similar to that described previously.

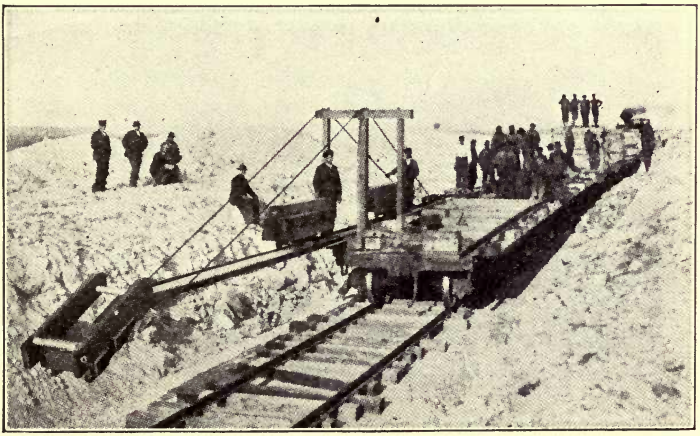

Fig. 11—Drummond Track Laying Machine.

Drummond Track Layer—The Union Pacific R. R. has used a Drummond Track Layer for laying new track, the process being described and illustrated in one of the instruction papers issued by the Educational Bureau of that road. The train is usually made up of the pioneer car, three rail cars, seven tie cars, a locomotive, and a car of trimmings including spikes, bolts, nuts, nut locks and tie plates. An illustration of this track laying machine is shown in Fig. 11.

Ties are carried ahead by small tie cars, running on a narrow-gage track which is supported on stringers projecting out beyond the right-hand side of the cars. A switch on the pioneer car allows the loaded tie cars to pass the empties. The track is extended 20 or 25 ft. ahead of the pioneer car and supported by cables swung from a frame bent. Rails are pulled ahead on dollies on the opposite sides of the cars, the dollies being outside the edge and supported on the protruding stringers. The men are distributed as shown in the table.

ORGANIZATION ON DRUMMOND TRACK LAYER.

4	men loading tie cars.
5	men pushing tie cars to front.
10	men laying and spacing ties.
2	men lining ties.
2	men placing rails on dollies.
12	men handling rails with tongs.
1	handy man.
6	men distributing spikes, bolts, nut locks, and tie plates.
2	men spacing ties behind the machine.
12	spikers.
6	nippers.
2	liners.
2	water carriers.
66	

*__Track-laying with an Improvised Pioneer Car__—Some time ago I was employed to take charge of the track-laying on a 48-mile extension of an electric interurban railroad. I took charge after approximately seven miles had been laid. The work had been started by using two "iron cars" to carry the rails forward, but that method proved to be slow and expensive.

There being no track-laying machine available, a "Pioneer" car was improvised as follows: The forward truck

*Contributed by S. J. Evans.

and draft gear of a 36-ft. wood-frame flat car was removed; one of the "iron cars" was placed under the forward end of the car in place of the truck, the forward end being thus lowered so as to make an incline of 16 in. in 36 ft.

Upon the "deadwood" of the flat car there was belted the V-frame work of a stationary roller. This roller was 2 ft. in length and 4 in. in diameter, having a 2½ in.

Fig. 12—Improvised Pioneer Car.

flange on each end. The top of this roller projected above the floor of the car.

To the floor of the car the framework of three other stationary rollers were securely bolted, 12 ft. apart. These rollers were 14 in. in length, 4 in. diameter, with 2½-in. flanges. The centers of all four rollers were lined to the center of the pioneer car.

The rail cars were placed immediately behind the pioneer car, and upon each car three movable rollers were used. Under the forward end of the pioneer car, a strong

box constructed of 3-in. plank was hung. The bottom of this box was from a plank 3 x 12 x 10 in., against which were spiked pieces 3 x 8 x 10 in., which made the sides; two pieces 3 x 8 x 18 in. were spiked against the ends. This made a box 5 in. deep, 12 in. wide, and 10 ft. long. This box was hung under the car just far enough to clear the rear end of a rail when it was dropped upon the ties. The front strappers carried their bolts, nut locks, and shims in this box, or as they called it, the "pig trough."

Upon the pioneer car, ranged along the edges (longitudinally) was carried the "front" or forward supply of spikes, bolts and nutlocks. This stock was replenished each time the construction train left to return to the material yards.

The spike, bolts and nutlocks were unloaded from a supply car located immediately behind the auxiliary water tank. This car was unloaded while laying rail, and the pioneer car was spotted in front of the fastenings for loading when the material train left to return to the material yard. The front strappers and other men who were handling the front material loaded it upon the pioneer car after the train had left.

The "line up" of the train consisted of nine material cars, locomotive and tank, auxiliary water tank, supply car (carrying spikes, bolts, nutlocks, angle bars, the surplus and broken tools) and five carloads of ties.

The ties were unloaded from one side of the train and hauled ahead of the pioneer car by wagons, the "skinner" or teamster unloading the ties hauled by his team, each team alternately hauling 27 and 28 ties on tangents, and 30 and 31 on curves. Two wagonloads gave a sufficient number to lay half of the ties needed between 100-ft. stations; the balance of the ties needed for full-tieing the

track was unloaded from the opposite side of the cars to be placed under the rails later on. We were very careful in unloading the ties. As each team approached the train, the exact amount of ties needed to load the wagon was thrown from the cars, thus eliminating unnecessary hauling from far behind the train. (I have seen whole carloads unloaded in one pile and teams hauling from a distance of three-quarters of a mile from the end of the track.)

As we were laying the rails broken joints, the back ties were unloaded alternately, four and five ties each time the train stopped to lay a rail. An assistant foreman was in charge of the tie unloading gang and called to them at each step the number of ties required. By using this method we did not have a surplus in one place and a shortage in another.

Any one who has had much experience in tracklaying will agree with me that more often than otherwise, when track is laid with just half the ties required, later on when a train is sent out to distribute what ties are necessary to full tie, they will not make an even distribution. Much of this train's time and the time of the distributing gang will be used in picking up the surplus ties and in filling-in where ties are missing. This we avoided; in fact, in using the method described we had no picking up of ties to do. In one stretch of six miles we had a surplus of but four ties and none missing.

Nine teams and wagons were used in hauling ties ahead of the Pioneer car. The drivers did the unloading. We did not allow them to bunch the ties, but had them stop seven times between each 100-ft. station, unloading four ties at each stop, except that when a wagon had but 27 ties upon it, only three ties would be left to unload

at the last stop. A gang of four men loaded the ties upon the wagons.

At the front an assistant foreman and five men placed the ties on grade. They used a tie line about 300-ft. long and a spacing board 33-ft. in length. The board was 1x4 in., with a hole bored in the forward end for a short piece of rope to be passed through and tied so that it could be pulled forward. The board was marked, with a saw, 44 in. apart for laying ties on tangent. For ties on curves, notches 39½ in. apart were cut with an axe to distinguish them from the target markings. (The track was only half-tied ahead of the rail.)

The crown of the embankments was rounded off from the center, making an uneven beaming for the ties, so a team attached to a disc plow was employed in loosening up the top of the embankment ahead of the tie-placing gang. It was found that this gave the ties a uniform bearing for their length, after the construction train had passed over. This method proved advantageous as it kept the skeleton track in fairly good line until ballasted.

No spiking was done ahead of the construction train. Three bridle bars, constructed from ½ by 3¾ bar irons, were attached to each rail. The rails were held to place by a spike being dropped into a square hole which had been punched in the bridle rods flush with the inner flanges of the rails. The rail on the line side of the track was lined to the middle marks on the ties; the bridle bars were attached to it while the gage rail was being strapped, it was forced into the clutch of the bridle bars and the spikes dropped into place.

The ties were laid to support the joints, which made, when full tied, an even spacing of twenty-two inches on tangents and approximately 19¾ inches on curves.

When the Pioneer car was first put into use, the angle bars were carried from behind the engine and the bridle bars from behind the train; eight men were engaged in transporting these bars. Often delays would occur because of the men being unable to keep material ahead. At this time we were using 10 teams in the tie service and often the teams would be hauling ties a half a mile ahead of the Pioneer car. I considered any haul of over half a mile useless expenditure, so one team was taken out of the tie service and put to hauling the bridle and angle bars. These were loaded and unloaded by the teamster and one man; they placed a bridle bar between every third tie, and a pair of angle bars, alternately, between the fourth and fifth ties (only alternate ties having been laid). This made a saving of 10 per cent in the tie hauling and 63¼ per cent in the transportation of the bridle and angle bars; no delays occurred after the team was transferred from tie-hauling to transporting bridle and angle bars.

The organization of the track-laying force consisted of one general foreman, three foremen, three assistant foremen, one timekeeper, eleven teamsters with teams, and ninety-three trackmen, including three water carriers.

This force was distributed as follows:

THE FRONT GANG.

1 General Foreman—All foremen and assistant foremen reporting direct to him.
1 Timekeeper.
1 Team Foreman—In charge of all teams and team work.
1 Teamster and a four-horse team, discing.
9 Teamsters—With two-horse teams, hauling ties.
1 Teamster—With two-horse team, distributing bridle bars and angle bars.
1 Trackman—Helping teamster to distribute angle and bridle bars.

1 Assistant Foreman—In charge of gang placing ties on grade.
5 Men—Placing ties to tie-line on grade.
1 Man—Fiddling ties.
2 Men—Applying angle bars to forward end of rails.
1 Assistant Foreman (Heeler)—In charge of rail gang and front strappers.
2 Men—Strapping.
2 Men—Applying bridle bars.
2 Men—With lining bars throwing rail to fiddle marks on line side of ties, and moving gage rail to place in bridle bars.
12 Men—With rail tongs, catching rails as they come down the incline, and placing them in track; 8 men on the forward end and 4 men on the rear end.
2 Men—Incline men on Pioneer car. Holding rails on car in readiness for the signal from the assistant to "shoot it."
1 Man—With rail fork "breaking-down" on rail cars.
8 Men—On rail cars lifting rails onto the rollers and leading the rails to the incline of the Pioneer car.
1 Man—On supply car, dropping to the ground at the end of the ties, at each stop, the required amount of bolts and spikes for half a rail length; also placing angle bars on the outer edge of car to load wagons.
1 Assistant Foreman—In charge of the men unloading ties from cars and loading wagons with ties.
3 Men—In car, unloading ties from cars and loading wagons with ties.
3 Men—Unloading ties on opposite sides of cars for full tieing track behind the construction train.
4 Men—On the ground, loading ties on the wagon.

The Back Gang.

1 Foreman—In charge of the back gang.
2 Men—Strappers, tightening and full bolting.
1 Man—With lining bar throwing-in rail on gage side to release bridle bars.
2 Men—Releasing bridle bars and piling them on side of the embankment to be in readiness to load on wagon.
1 Man—Rail fiddler, marking tie-spacing on base of rail.
4 Men—With two light track jacks spacing ties to marks on rail base.

2 Men—Placing spikes on ties ahead of the spikers.
12 Men—Spiking, 6 men on line side, 6 men on gage side.
6 Men—Nippers, 3 men on line side, 3 men on gage side.
1 Man—With a lining bar moving gage rail for head gage spikers.
1 Man—With light push car gathering miscellaneous material.
1 Foreman—In charge of lining gang.
9 Men—Lining, 5 men throwing track to center stakes, foreman and 4 men bringing track to line between the stakes; this gang also picked up the very bad depressions in the track surface.
3 Water carriers.

While not striving to make a record, we laid 4,600 track feet of 70-lb. rail, half tied, in two hours and fifty minutes. We began laying at 8:15 a. m., and all the rails on the cars were unloaded and laid at 11:05 a. m.

We had but one engine while laying the first 25 miles of this extension, therefore we were only able to lay rails in the forenoon of each day. In the afternoon we laid the ties in full, and part of the gang was employed in picking up depressions in the track surface. When a second engine was put into the track-laying service, and we were able to lay rail throughout the day, as much as 9,450 track feet of rail were laid in a day.

An additional gang of 40 men, one foreman and one assistant foreman, was employed to full tie the track, this force being distributed as follows:

1 Foreman—In charge of the spiking.
1 Assistant Foreman—In charge of the tie gang.
18 Men—Carrying ties up the embankment and placing them under the rails, four track jacks being used to raise the rails so the ties could be inserted.
12 Men—Spiking, 6 on the line side and 6 on the gage side.
6 Men—Nipping, 3 on the line side and 3 on the gage side.
2 Men—Peddling spikes.

2 Men—With wooden mauls spacing ties squarely with the rail and centering the ties to the marks on the base of the rails.

Use of Derrick for Laying Track—In the Union Pacific instruction paper mentioned above, a method of track laying is described which is somewhat as follows: The train consists of one car of rails (trimmed), a derrick, a car containing switch material, bolts, spikes, nut locks, etc., a locomotive, a car of tie plates, 3 or 4 cars of ties and a tool car. The derrick rail unloader is operated by compressed air from the engine and it unloads the rail alongside the rail car. The rails are carried ahead by 16 to 20 men using rail tongs. Bridle rods are generally used, and spiking is done in the rear. Teams deliver enough ties ahead to hold up the track.

The Work in Detail—The work done by the various members of a rail gang is given below, the men being located as shown in Fig. 13.

(1) Tie Fiddler—Marks on each tie the proper position for the outside of rail base.

(2) Tie spacers—Move ties to proper spacing.

(3) Gage man—Places track-laying gage on extreme ends of rails.

(4) Steel gang—Carries rails to place and sets them up in track.

(5) Rail nipper—Raises one rail if necessary to help strappers get joint bolts started.

(6) Strap hangers—Hang the angle bars to receive the rails being set up.

(7) Strap tighteners—Tighten bolts behind strappers.

(8) Joint plate peddler—Distributes the joint base plates.

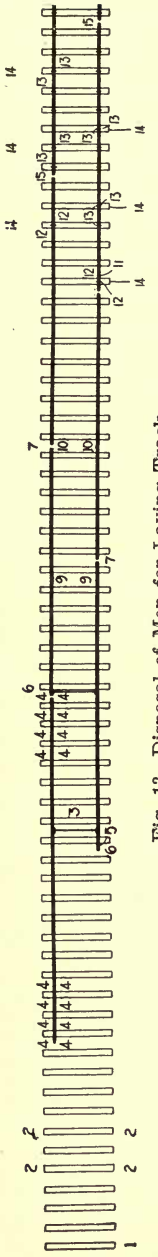

Fig. 13—Disposal of Men for Laying Track.

(9) Spike and bolt peddlers—Distribute spikes and bolts.

(10) Tie plate peddlers—Distribute tie plates.

(11) Gage liner—Throws gage rails to gage.

(12) Head spikers—Spike track to gage, on 4 or more ties to the rail length.

(13) Back spikers—Finish or partially finish spiking the track.

(14) Tie nippers—Hold up ties for spikers.

(15) Back bolters—Finish joint bolting.

(16) Tool man—Keeps tools in good condition, keeps track of tools, and distributes them.

Tie Fiddler—The tie fiddler places the fiddle on the face of the tie (on the line side of the track) with the cleat securely against the end, and a mark is made on the tie along the uncleated end of the fiddle. The outside line spike should be set on this line when spiking. Before marking a tie, the fiddler should examine it and be sure that the right side is up. The tie fiddler will generally be able to run ahead of the gang without difficulty, and he should find time to set the tie lines, also. For this purpose it is handy to have a board of such length that if one end is placed against the center stake, the opposite end will show the proper place to set the tie line. The tie line is a

rope stretched to show where the ends of the ties on the line side of the track should be placed.

Tie Spacers—Behind the tie fiddler are two tie spacers. They are usually provided with a rod of the same length as the rail which is to be laid, or a wire rope cable, three rail lengths or more long, having the tie centers marked on it with white paint. The rod or wire is laid on the ground with the rear end even with the head of the last rail laid, on the line side of the track. Tie tongs should be used by the tie spacers in dragging the ties to center, and line. These tools prevent mutilating the tie, give a firm grip and make it possible to handle ties much faster and easier. The man on the line side pulls the tie to the line previously stretched, and the man on the gage side places the end so that it lies square across the grade. In order to keep ahead of the rail gang the tie spacers must space ties for a full rail length while the steel gang is setting up two rails; four tie spacers are sometimes needed. Sometimes it may be necessary to dispense with the spacing ahead and do it behind the rail gang on account of lack of time, but this is more difficult. The spacers should inspect all joint ties, and if the latter are deficient in size or quality, they should be exchanged for those of better grade. Ties should not be pulled up against the tie line, but should be left ¼ inch away, for if allowed to touch the line, some of them will probably throw a kink in it. The tie line might be stretched about a foot above the ground, thus preventing the ties from touching it.

Rail Gang—The rail gang picks up the rail and sets the rear end on the ties, at the same time entering the rail ball into the angle bars hung on the rail previously laid. The head end of the rail is dropped at a word from

the heeler, and this movement throws the rail into proper position in the angle bars. The heeler now gives the command "heel" and the rail is pulled backward against an expansion shim. In setting up the line side, the assistant foreman should see that the rail is set as near as possible to its correct line as shown by the fiddled chalk marks on the tie; the gage rail should also be placed approximately in the correct position. It is just as easy to set the rails in their correct places, and if this is done, very few ties will have to be moved by the line spikers, the work of the gaging spikers will be reduced to a minimum, and the track will require but little lining. The assistant foreman should carry a wooden rail square, and test every third or fourth joint to see if either side is running ahead.

Gage Man—The gage man carries a rail laying gage, which has projections to engage both sides of each rail head, holding the rails from either spreading or narrowing. Such a gage can be made from a wooden strip by nailing two blocks across it at each end with space between each pair of blocks for the rail head. A nipper is provided to help set up the rails and put them in their proper places in the angle bars. He carries a bar to raise the angle bars or rails, as necessary.

Strap Hangers—The strap hangers use short-handled wrenches, which are handier and permit faster work. As soon as the rail is set up, the strapper hangs a pair of angle bars on the head end. As the next rail is heeled into place he puts in one joint bolt, and after giving the nut a few rapid turns, goes ahead and repeats the operation. Two bolt-tighteners follow and turn up the nuts which the strappers have started. When the rail gang is not setting up rails, the strappers may work ahead,

close enough together so that he (the foreman) always has them under his immediate supervision. Before gaging the rails at joints, the bolts should be tightened in order to prevent bad gage or lips.

Back Bolters—The back bolters bolt the joints in full and turn up each nut as tightly as possible with an ordinary track wrench. Since back bolting requires little skill and only ordinary strength it is a good place to start in green or inexperienced men. If pipes are used on wrenches to give greater leverage, the bolts are likely to be turned up so tight that the expansion cannot run, and sometimes the nuts will be twisted so hard that the bolt will be twisted in two and have to be thrown away.

Tool Man—One of the most important men on the gang is the tool man. If a good trustworthy laborer is selected for this position, he may save the foreman much trouble. He is held accountable for the number of tools on the work each day, and also for the tools in the boxes. The condition and supply of tools is left entirely to him and in case any are in bad order it is his business to exchange them for good tools. If necessary he must use his own ingenuity in repairing those on hand or "borrowing" from other gangs. A live tool man will be on the lookout and know when new tools arrive on the job and thus be sure of obtaining his share. Although little hard work is required, a tool man should be chosen who is industrious, reliable and intelligent; in fact he should be one of the best trackmen in the gang.

Assistant Foreman—When setting up rail, the assistant has charge of the steel gang, strappers, tie spacers, and the fiddler. If these men are able to run far ahead of the spikers, setting up rail can be discontinued and the rail gang organized into spikers, bolters, etc. The assistant

foreman is held responsible for proper expansion in the track, and must be careful to use shims of the proper thickness. Proper expansion cannot be secured if the rails are set up loose and the angle bars left off. It is really easier to hang the angle bars and bolt the joints when laying, and this method is the only one which will insure correct expansion.

Before setting up the rails they should be measured carefully with a steel tape or wooden rod, and the longer ones marked. When joints run behind on one side, the long rails should be used on that side until the joints again come to their proper relative positions. Thicker expansion shims should never be used to square up joints. In laying track with broken joints, which is the more common practice on both tangents and curves, the question of the relative position of joints is not so important, though even here it is necessary to give the matter careful attention. The Pennsylvania allows the joints to run 8 inches forward or back from the center of the rail opposite. If matched or even joints are not square the joint ties will be badly slewed. The rail square will not indicate the exact relative position unless the rails are nearly to line and gage. A small kink on the line side may throw the gage end of the square an inch or more from the proper position.

Foreman—The foreman should instruct his assistant as to the proper expansion shims to use, and when to change to a thinner or thicker size. The temperature of the steel is what should govern and not that of the air. The temperature of the steel in general, lags below the air temperature in the morning, and is higher in the afternoon. If a sub-grade is rough and uneven, greater expansion should be allowed, as the track will shorten when

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brought up to surface. The track laid during the day should be lined late in the afternoon to prevent shortening, as that laid in one day will move ahead when the short kinks are lined out; if lining is neglected for several days, the weight of the track becomes too great to move ahead, and when the kinks are straightened out the expansion will be closed up, leaving tight track.

When laying rails from a flat car, the layers of rails below the top are likely to be far below the temperature of the air or the top layer of rails. Constant attention should therefore be paid to the temperature of the steel being laid in this manner.

In case the number of men is too small to make a well rounded organization and produce finished track at one operation, the organization at the front must be kept complete at the expense of the back work. Then after a number of rails have been laid, the gang can be broken up and taken back to finish up the work.

The foreman is responsible for both the quantity and quality of work done. He must organize the gang, and be ready at any time to make changes required when some of the laborers are absent. If a number of men leave at the same time and new men are not available, the whole gang must be reorganized. As the assistant foreman's time is constantly taken up with the rail gang, the foreman must supervise the spiking and back bolting as well as inspect the work of the assistant foreman, as he is responsible for everything done by the gang.

Anti Creepers.—Anti creepers, whenever they are necessary, should be applied when laying track, as it is easier to prevent than to stop rail creeping. The anchors should be of a design which will stick to the rails under all conditions, and really prevent creeping.

Conclusion—The methods of track laying with the different machines vary but little. The advantages of using a track-laying machine are mainly economy and efficiency in handling material and rapidity of track laying. A saving of at least $50 per mile is possible and in most cases the saving would be $100 to $150 per mile.

CHAPTER V.

BUILDING SECOND TRACK.

Double Tracking—Building a second track or "double tracking" is simpler than building a track over a new line, because the new material can be distributed from the old track. Great care should be exercised in the distribution of material. When unloading ties, the number of rail lengths or telegraph poles the train covers should be counted up, and the train moved ahead the same number of rail lengths or telegraph poles for each spot. The number of ties necessary for that distance can be figured out and this number unloaded each time the train stops. A couple of extra ties should be thrown off at each spot to take the places of unsound ones.

Distributing for Second Track—When building a second track, that is, when double tracking, the material is usually distributed by a work train, which necessarily uses a track on which there is more or less traffic. The material is sometimes distributed a long time before the track gangs get on the work. In fact the work train is frequently taken off entirely before track laying begins; then if there is a shortage of steel the track gang will be forced to transport rails by push car until a work train can be again secured. It is better to have too many than too few rails and ties as far as the track laying gang is concerned. However, surplus material must be reloaded, which is an unnecessary expense. A shortage of ties will temporarily break up the organization of the track gang, for if the men are properly placed to just handle the

work when the ties are correctly unloaded, some of the men will be overworked and others underworked when there is a shortage; and when fill-in ties arrive after the rail is laid, the organization must be broken up and men taken back to finish up the track. When distributing rails on a track under regular traffic, the work train is frequently run to a siding to let another train pass. In these intervals the gang should be kept busy setting up the rails end to end on the shoulder of the grade. If there is time to set up all the rails in this manner, the distribution will be exact, giving a corresponding advantage when laying or relaying track.

If just enough rails and ties are unloaded, and yet they are not properly placed, that is, if they are unloaded in bunches, the redistribution must be made with a dumpy on the main track, and one or two men must be taken out of the gang to act as flagmen. If the rail gang or tie spacers must redistribute any material they will be unable to keep ahead of the rest of the gang and the organization will again have to be broken up in order to get a full day's work out of each man.

All of these arguments may not be necessary to show that track material should be properly distributed. It is conceded that it should be, but nevertheless it is true that all too frequently track material *is* poorly distributed. Correct distribution from a main track can be obtained by noting the standard length of track rails and spotting the material with respect to the rail joints, and unloading rails, spikes, ties, angle bars, etc., in the proper proportion. If it is desired to keep the train in motion while distributing material, for instance when distributing bolts, spikes, angle bars, etc., an easier method is to gage the distribution by the telegraph poles, which are spaced at stand-

ard distances and can be seen without trouble by the men on the cars.

Unloading Rails—Unloading rails by hand, especially from stock cars, is slow and laborious. This fact, as well as the danger of rails breaking in cold weather, has led to the development of several ingenious methods of unloading rails. When unloading from flats in warm weather many track men consider it safe to shove the rails over the edge of the cars, using a gang of 2 to 4 men with rail

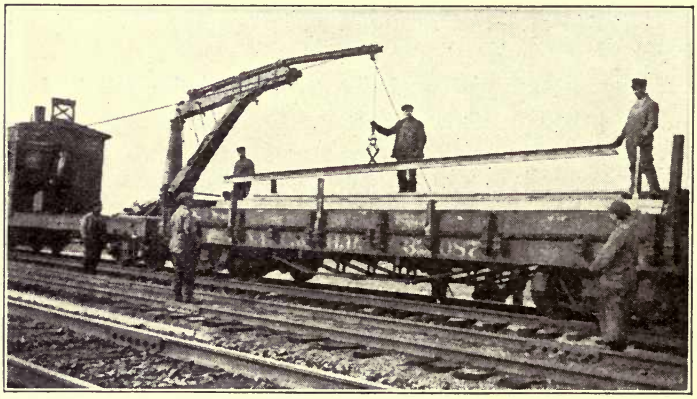


Fig. 14—Improvised Rail Derrick with Old Rails for Boom.

forks, or 8 to 14 men with shovels. This method should not be used in the winter time when the rails are cold and brittle and the ground is frozen hard. Under these conditions, skids, a rail derrick, or some other means should be employed.

Rail Derrick—For unloading heavy rails portable derrick attached to the sides of cars have been used. Six men only are required, and rails can be unloaded at the rate of one per minute. The derricks are light and can

be easily transferred from car to car. They are set up in the stake pockets.

Air Unloaders or Locomotive Cranes—Recently air unloaders and locomotive cranes, have been used for unloading rails and good results reported. Several cranes used with one locomotive and train crew have made records both for speed and low cost of unloading.

Unloading Rails from Flat Cars—When flat cars are used, the rails are sometimes hauled off the rear over

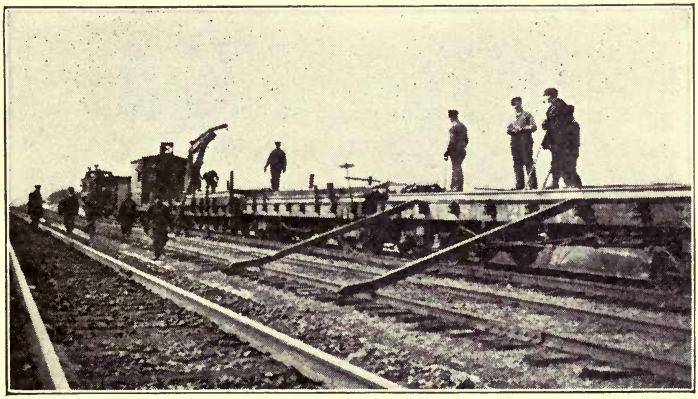


Fig. 15—Ingenious Use of Skid Rails.

dollies, using cables as described below under V-frames.

Mr. A. M. Clough, in the Maintenance of Way Bulletin, March, 1913, described a very ingenious arrangement of skids for unloading rails and also an improvised derrick for loading. The derrick was built of parts of an old wrecker fitted with an extension boom of two 30-ft. rails. (Fig. 14.) This machine takes care of all rail loading and unloading on the division. A loading speed of 4 rails per minute can be attained.

Skids—The skids for unloading fit into the car pockets in the ordinary manner, and reach clear across the adjacent track. (Fig. 15.) The skid rails are chained together and the front skid is chained to the car ahead of the one being unloaded in such manner that the skids are dragged along perpendicular to the car, when the train moves. The skids slide on the rail, and require no attention when the train moves. When necessary to clear the track, which is protected by flagmen, the skid rails are uncoupled, the car is moved ahead, and the skids swing around clear.

To retard the speed oak strips are bolted along the sides of the skids and are made to project high enough to retard the rail. As the wood wears off, the strips are raised a little, the bolts being in slotted holes which allow of this adjustment.

V-Frames—A V-Frame is made by bending a short rail in the shape of a V, after removing about 12 in. of the web and flange at the middle. The outer ends are bent horizontal so they will rest on the track rails, and the V is inverted and placed in position on the pin in the draw bar, as shown in Fig. 16. Two plates are riveted on the bases of the V rail to form shoes which slide on the track rails. The knuckle is removed from the coupling and a round pin with a high head is inserted to hang the V on. The V-frame is used for unloading out of the end doors of stock cars, or off the ends of flat cars.

Two wire ropes or rope cables are provided, about 20 ft. long, each having a hook in one end to insert in the bolt hole of the rail, and a loop, or preferably a clamp, in the other end. The hooks are inserted in two rails, and the rope may be anchored by means of bars, stuck through the loops and driven into the ground back of a tie, out-

side of the rail; clamps which will catch the ball of the rail are much easier to use, however. When the train starts, the two rails are dragged out of the car toward the opposite sides of the track. When the end of the rails next the car fall, they slide down the V-frame and outside

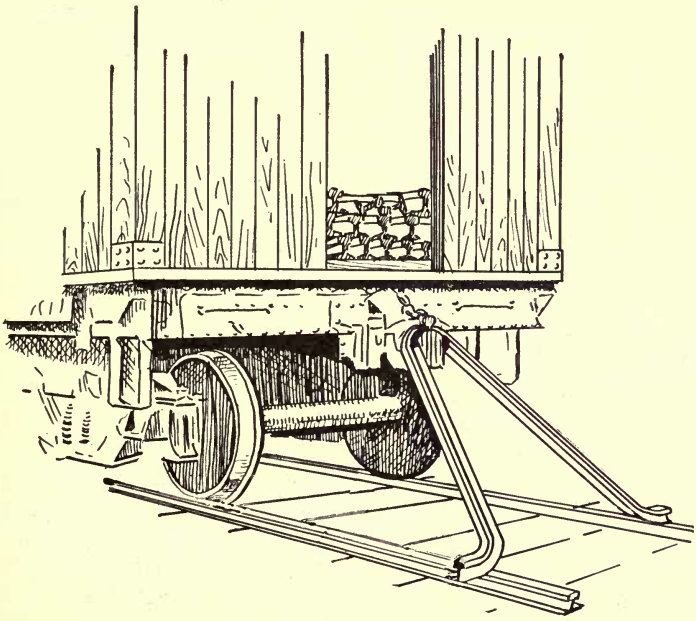


Fig. 16—V-Frame for Unloading Rails from Stock Cars.

the track. The train then stops, backs up a little, and the operation is repeated. Two men are required for the anchor (lining) bars, or clamps, 6 in the car, and 2 straightening up the rails.

Fig. 16-A shows a V-frame of a little different type, mounted on a dump car which is coupled to the stock car by a long coupling.

Four cables may be used, two of them being 33 ft. longer than the others. The cables can then be anchored at alternate rail lengths and the distribution made correctly without backing up. The train is stopped just before the first pair of rails has fallen, to give time to fasten the hooks in

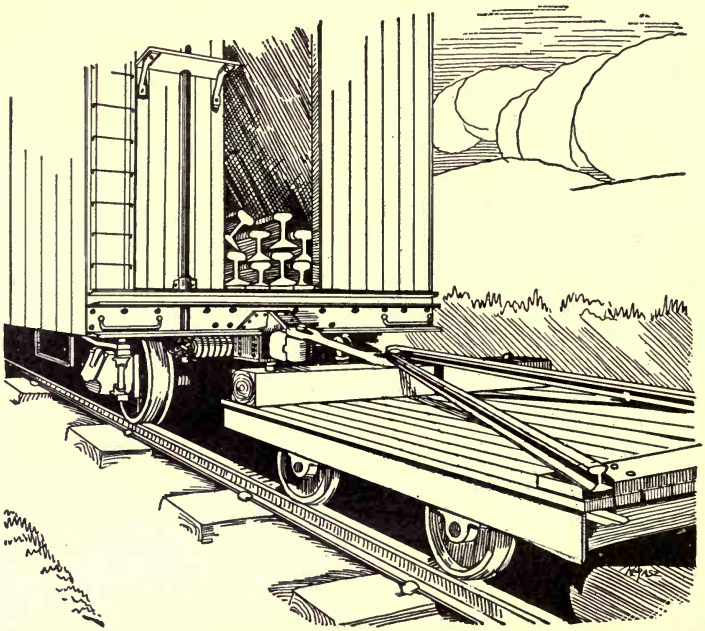


Fig. 16-A—V-Frame Mounted on Dumpy.

the next pair of rails. The first pair of rails will drop after the train starts again and has moved 3 or 4 ft. and the other two rails will be started and dragged out 25 or 26 ft., at which time the train again stops.

Placing Rails—The advantage of accurate distribution of material can hardly be overestimated in relaying track. While waiting for trains, when distributing

material, the gang should be kept busy setting up rails end to end to insure correct distribution; and the joint ties can be distributed just where they are likely to be needed, during such intervals. The time between trains, which otherwise would be wasted, is thus used to place the material so that track laying will be facilitated.

Distributing Ties.—The tables given have been worked up to give figures which can be used in distributing material by noting either the telegraph poles or the rail joints, for either 30 or 33-ft. rails. The figures in most cases have been carried out only to the nearest quarter keg, box, etc., so that they can be easily used by men who are not used to handling fractions.

TABLE 1: DISTRIBUTING TIES ACCORDING TO TELEPHONE POLES.

	30-ft. Rails		33-ft. Rails	
No. per rail Length	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart
15	75	100	....	.....
16	80	107	....	.....
17	85	114	78	103
18	90	120	82	109
19	95	127	87	115
20	....	.....	91	121
21	....	.....	96	128

Table 1 is for distributing ties for a new track. It is customary to take out several carloads at once and assign several men to each car. The train is generally moved about one train length for each spotting. When spotting according to rail lengths a man may be sent ahead to make a chalk mark on the rail joints at intervals which gives the nearest equivalent to the train length.

Distributing Angle Bars.—Table 2 gives the number of angle bars required per rail length, and per telegraph pole whether located 150 ft. or 200 ft. apart. It is some-

times easier to gage the distribution by telephone poles than by rail lengths, but if the rails have already been distributed, the best method is to throw off four angle bars and two joint plates, or two joints, for each rail length. It is not necessary to distribute extra pieces, because these appliances are not so easily lost as spikes or bolts.

Distributing Track Bolts.—Table 3, for the distribution of track bolts, gives in its various columns the num-

TABLE 2: DISTRIBUTING ANGLE BARS OR JOINTS.

	Per Rail Length	Per Telephone Pole 150 Ft. Apart		Per Telephone Pole 200 Ft. Apart	
		30-ft. Rail	33-ft. Rail	30-ft. Rail	33-ft. Rail
Angle bars.....	4	20	18*	28	24**
Joints (or joint plates for angle bars).....	2	10	9†	14	12††

*2 extras at every 10th pole.
†2 extras at every 20th pole.
**2 extras at every 8th pole.
††2 extras at every 16th pole.

ber of joints which one keg will full-bolt for either 30 or 33-ft. rails, and for either 4-hole or 6-hole joints. For instance, if 4¾-in. by 1-in. bolts are to be used on 100-lb. 33-ft. rails with 6-hole angle bars, column 2 (below) in the table shows that there are 109 bolts to the keg, and column 3, that these will full-bolt 9 joints, and column 4, that they will bolt the joints between 2 telephone poles 150 ft. apart, or column 5, 1¼ telephone poles 200 ft. apart. In making the distribution it is impossible to divide up the kegs, so that with telephone poles 150 ft. apart, one keg should be thrown off at intervals of two telephone poles. For telegraph poles 200 ft. apart, one keg should be thrown off at every pole, and one extra keg at every fourth pole. The kegs should be rolled off the car end-

TABLE 3: DISTRIBUTING TRACK BOLTS.

4-hole Joints—One Keg Will Full-bolt.

Kind	No.—Per 200-lb. Keg	Joints	33-ft. Rails: Telephone Poles 150 Ft. Apart	33-ft. Rails: Telephone Poles 200 Ft. Apart	30-ft. Rails: Telephone Poles 150 Ft. Apart	30-ft. Rails: Telephone Poles 200 Ft. Apart
¾ in. x 3½ in.	255	31¾	7	5¼	6¼	4¾
¾ in. x 4 in.	237	39½	6½	4¾	5¾	4¼
⅞ in. x 4 in.	168	21	5¾	3½	4¼	3
⅞ in. x 4¼ in.	162	20¼	5½	3¼	4	3
⅞ in. x 4¾ in.	141	16½	4½	2¾	3½	2½
1 in. x 4¼ in.	119	14¾	4	2¼	2¾	2¼
1 in. x 4½ in.	114	14	3¾	2¼	2¾	2
1 in. x 4¾ in.	109	13½	3¾	2¼	2¾	2
1 in. x 5 in.	106	13	3½	2	2½	1¾
1 in. x 5¼ in.	103	12¾	3½	2	2½	1¾
1 in. x 5½ in.	100	12½	3¼	2	2½	1¾
1 in. x 5¾ in.	98	12	3¼	2	2¼	1¾
1 in. x 6 in.	94	11¾	3¼	1¾	2¼	1¾
1 in. x 6¼ in.	91	11¼	3	1¾	2¼	1
1 in. x 6½ in.	87	10¾	2¾	1¾	2	1

6-hole Joints—One Keg Will Full-bolt.

Kind	No.—Per 200-lb. Keg	Joints	33-ft. Rails: Telephone Poles 150 Ft. Apart	33-ft. Rails: Telephone Poles 200 Ft. Apart	30-ft. Rails: Telephone Poles 150 Ft. Apart	30-ft. Rails: Telephone Poles 200 Ft. Apart
¾ in. x 3½ in.	255	20	4½	3½	4¼	3
¾ in. x 4 in.	237	19¾	4¼	3¼	3¾	2¾
⅞ in. x 4 in.	168	14	3	2¼	2¾	2
⅞ in. x 4¼ in.	162	13½	2¾	2	2½	2
⅞ in. x 4¾ in.	141	11¾	2½	1¾	2¼	1¾
1 in. x 4¼ in.	119	9¾	2	1½	2	1½
1 in. x 4½ in.	114	9½	2	1½	1¾	1¼
1 in. x 4¾ in.	109	9	2	1¼	1¾	1¼
1 in. x 5 in.	106	8¾	1¾	1¼	1¾	1¼
1 in. x 5¼ in.	103	8½	1¾	1¼	1½	1¼
1 in. x 5½ in.	100	8¼	1¾	1¼	1½	1¼
1 in. x 5¾ in.	98	8	1¾	1¼	1½	1
1 in. x 6 in.	94	7¾	1½	1¼	1½	1
1 in. x 6¼ in.	91	7½	1½	1¼	1½	1
1 in. x 6½ in.	87	7¼	1½	1	1¼	1

Sizes of Bolts to go with Plain Bars of the Following Sections:

45 to 67 lb.	70 and 75 lb.	80 and 85 lb.	90 and 100 lb.
3½ x ¾ in.	4 x ¾ in.	4¼ x ⅞ in.	5 x 1 in.

Sizes of Bolts to go with Patented Joints:

	45 to 67 lb.	70 and 75 lb.	80 and 85 lb.	90 and 100 lb.
Continuous	¾ in. x 3¾ in.	⅞ in. x 4 in.	⅞ in. x 4¼ in.	⅞ in. x 4¼ in.
Bonzano	1 in. x 4¼ in.	1 in. x 4¼ in.	1 in. x 4½ in.	1 in. x 4½ in.
Wolhaupter	1 in. x 4¼ in.	1 in. x 4¼ in.	1 in. x 4½ in.	1 in. x 4½ in.
100 per cent	1 in. x 4¾ in.	1 in. x 5 in.	1 in. x 5¼ in.	1 in. x 5½ in.
Weber	1 in. x 5¾ in.	1 in. x 6 in.	1 in. x 6¼ in.	1 in. x 6½ in.

ways; if they hit on the sides they may run down an embankment into the ditch.

Distributing Nut Locks—Nut locks are usually furnished in boxes of 1,000. Table 4 gives the number of

TABLE 4: DISTRIBUTING LOCK NUTS.

Nut locks—1,000 in a box—one box will furnish nuts for

	4-hole joints—8 nut locks			6-hole joints—12 nut locks	
	Joints	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart	Joints	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart
33-ft. rail....	124	27½	20½	83	18½	14½
30-ft. rail....	124	25	18½	83	16½	12½

joints, measured by telegraph poles, for which one box will provide nut locks, the left half for two 4-hole joints requiring 8, and the right half for two 6-hole joints requiring 12. A few nut locks are likely to be lost, so it is advisable to disregard the fractions (for instance, in columns 3 and 4, top row of figures) and to unload a box of nut locks every 27 telegraph poles 150 ft. apart, or every 20 telegraph poles 200 ft. apart. Where poles are only

TABLE 5: DISTRIBUTING TRACK SPIKES

Size, Length Measured Under Head	Average No. per Keg of 200 lb.	Rail Used, Weight per Yd. lb.	One keg will full spike-rail lengths: 15 ties per rail	16 ties per rail	17 ties per rail	18 ties per rail	19 ties per rail	20 ties per rail	21 ties per rail
5½ in. x ⅝ in.....	300	75 to 100	5	4½	4¼	4	3⅞	3¾	3½
5½ in. x 9/16 in.....	375	45 to 75	6¼	5¾	5½	5	4¾	4½	4⅜
5 in. x 9/16 in.....	400	40 to 56	6½	6¼	5¾	5½	5¼	5	4¾

100 ft. apart, the amount of track material to be unloaded will be one-half of that for the 200-ft. spacing.

Distributing Track Spikes—Table 5 gives the number of track spikes, of the sizes commonly used, in an aver-

age keg of 200 lb. The number of rail lengths which one keg will full-spike is shown in columns 4 to 10, inclusive.

Simultaneous Distribution—The cheapest and best way to distribute the spikes, angle bars and base plates or joints, bolts and nut locks, is to make up a train to do all this work at once. It is possible to make all this distribution without stopping, with the train traveling at a speed of 8 to 10 miles an hour.

Organization for Laying Track—Whenever time is available, the ties should be distributed on the grade, and lined and spaced. After this work is done a track gang of 48 men could be organized as follows:

Tie fiddler	1	Spikers	12
Tie spacers	2 or 4	Tie nippers	6
Steel gang	12	Gage liner	1
Gage man	1	Back bolters	2
Rail nipper	1	Tool man	1
Strap hangers	2	Water boy	1
Strap tighteners	2		—
Joint plate peddler	1		48
Spike and bolt peddler	1		

The assistant foreman should carry a light wooden rail square and test every third or fourth joint to see if either side is running ahead.

Lack of Men—In case there are not enough men to be organized completely for all the necessary operations, such work as peddling material, fiddling and lining ties and hanging angle bars on rails can be done before starting to lay track. Spiking can be partially done while setting up the steel, and back bolting can be done after steel is set up and gage-spiked. Track should be jointed up and gaged when laying, in order to insure correct expansion. If rails are set up and the angle bars not put on, it is impossible to keep some of the expansion shims from falling out, and the ends of rails are likely to run

past each other and necessitate shifting a number of them when jointing up. Before gaging, joints should be thoroughly tightened in order to prevent bad gage or lips.

The remarks on page 94 about allowing more expansion on uneven grades and in sags, and lining up track each day, apply with equal force to laying second track.

Setting Up Rails—The rail gang men use rail tongs, instead of handling with the hands as in laying track on a new line. Usually the heeling in is done with the tongs, although the same method may be used which is described on page 89. Rail tongs should be of uniform make, with distance from handle to rail hook the same, for if this is not the case some of the men will carry an excessive weight, and others practically none.

The rest of the force is organized and performs duties similar to the detailed outline in Chapter 4. Before spiking a tie, the nipper on the head gang of spikers should see that the outside of the base of rail is nearly in line with the fiddled chalk mark on the ties. If it is not in line, he should move the rail over approximately to line with his nipping bar. This point is important enough to bear repetition here.

Tool Boxes—A very handy way of taking care of tools and surplus material, in double tracking, is to put the tool boxes on a push car or dumpy, on the track which is being built. The tool man can shove the car along as the work advances. He can take out the shims and pick up scattered tools and light track material, loading them on the car. In this manner excess tools and materials are kept conveniently at hand for emergencies. The dumpy should be securely locked to the rails each night, using a heavy chain and padlock.

CHAPTER VI.

TURNOUTS, CROSSOVERS AND LADDER TRACKS.

More attention is required in distributing material for switches than for track, on account of the great number of different parts, the absence of any of which may seriously delay switch work.

Size of Gang—On account of the many small but important details which must be attended to in laying switches, this work should in general be placed in charge of an experienced foreman. More careful supervision is necessary than in any other kind of track work, and unless good intelligent men are obtainable for assistant foremen, it is advisable to keep the gang small enough so that the foreman may oversee all the work himself.

However, in laying ladder tracks it is possible to advantageously handle a gang of 40 good track laborers with one good assistant and a handy man. Inexperienced foreign laborers must be carefully watched to prevent them from spiking down a switch point, setting a switch-stand with the lever in the wrong position, or doing other work in a manner which detracts from the quantity and quality of work accomplished.

Kind of Laborers—There is an advantage in working foreign laborers, if men of some skill and experience and a good assistant of the same nationality can be obtained, for foreigners generally stay on the job and the same men can be depended upon from day to day. When working hobo labor it is not uncommon for 25 per cent of the gang to quit the work at one time, and after a pay-day hardly any of them can be depended upon. For this

reason it is practically impossible to always keep a sufficient number of hobos to fill out the organization. It is generally safe in sending an order to a labor agency for this class of men to order at least twice as many as are actually needed, for half of them will drop off before reaching the job and by the time a shipment arrives there is likely to be many more vacancies to be filled.

American labor is more easily handled at points away from large towns. A gang of foreigners becomes a small union in isolated places, and the discharge of one man is likely to cause a strike of the entire gang. In large cities, foreign laborers are more easily replaced and they cannot employ the same methods.

Putting in Switch Ties—Four methods are suggested for putting in switch ties: (1) Put in one or two ties at a time as in renewing ordinary track ties; (2) after excavating, send out flagmen, jack up the rails, remove all the old ties, and put in the switch ties; (3) after excavating send out flagmen, pull spikes on from 8 to 12 consecutive ties, jack up the track, remove these ties and replace with switch ties; (4) after excavating take out every other tie, put in half or all the switch ties, spike enough new ties to hold the track to gage, then remove the remaining old ties and replace with the remaining switch ties.

Method No. 4—The following outline shows how the work should be arranged when putting in ties under method No. 4:

(1) Put out slow flags and flagmen.

(2) Mark the switch point, the frog point, and heel of the frog on the base or web of the old track rail.

(3) Start stripping out the ballast at one end of the switch, and work toward the other end.

(4) Mark off the center for each tie on the flange of the rail, and, starting at the point of switch, number these marks consecutively.

(5) Measure the ties and start placing them in order of length, opposite their proper positions in the switch. Starting at the head block, number the ties consecutively.

(6) Start men pulling spikes from every second tie—inside spike on one rail, outside spike on the opposite rail. Raise the spikes on 6 to 8 ties at each end of switch.

(7) Starting at one end of the switch, place jacks and raise each rail, withdraw unspiked ties, and put in one-half or all of the switch ties. Move jacks ahead and repeat.

(8) Spike the rails to every fourth tie (temporary spiking).

(9) Pull the spikes from remaining track ties, using the same claw-bar men.

(10) Double in behind claw-bar men with jacks, remove old ties and space the switch ties correctly.

(11) Surface and line the track.

(12) Fill in the track.

If the track is to remain as it is for some time without putting in the switch, the spikes should be driven home; otherwise they may be left loose enough to make pulling easy. If only every fourth tie is spiked, they will hold track to gage and fair surface, and a train may pass at any time at reduced speed. When the jacks are removed, the track will again settle down to the original grade if the stripping has been correctly done. Only those ties should be spiked which can be moved to their correct location.

Before lifting the track the spikes should be raised

on six or seven ties ahead of and behind the switch, high enough to prevent these ties being lifted off their beds. If this precaution is not taken, ballast is likely to run under these ties spoiling the surface of the track.

Before stripping out the ballast the location of the point of switch, the heel of the frog and each joint should be marked on the rail, as before mentioned. The marks of the ends of the switch should be given first, in order to show where to start stripping out. The ballast should be removed at least 6 in. beyond the ends of the ties, but no ballast should be handled unnecessarily. The depth excavated should not be more than ½ in. or at most 1 in. below the bottom of the tie. Excavating deeper than necessary not only wastes labor, in removing and replacing the ballast, but softens the track foundation.

The full set of switch ties should be measured and marked consecutively according to their lengths in feet and inches, 1, 2, 3, etc., from the head block to the end of the set and after the ballast has been stripped out, the switch ties should be laid down at right angles to the track in the exact order of their lengths, and if possible directly opposite their proper positions. The number of each length to be used will usually be furnished the foreman as one of the standards of the road; otherwise the sets given in the table at the back of the book can be used.

Uniform spacing should be laid off so that a tie will come at each joint slot, and so that the standard number will come under the lead rails, switch rails and frog. These space marks should be made on the web or the flange of the rail, so they will not be erased by passing trains. The center marks should be numbered consecu-

tively, 1, 2, 3, etc., to correspond with the numbering of the ties. No. 1 tie can then be launched directly under the No. 1 mark; No. 2, under the No. 2 mark, etc., after the track is raised.

Method 4 for putting in switch ties keeps the track safe for trains at reduced speed if the work is followed out systematically from one end of the switch to the other. By the time the first half of the track ties are removed, the spikers have enough switch ties spiked to allow the jacks to be placed behind them without delay. This method is safer and causes less delay to trains than the second; is cheaper than the third; allows the laborers to be organized into several gangs which continue doing the same kind of work, and thereby promotes efficiency. This method can also be used with a very large gang without the men interfering with each other, therefore it is a very good method to use where work is desired in a hurry.

The method of placing two or three ties at a time is costly, the advantage being that the track can be kept safe for trains at high speed.

A Typical Switch—A switch consists of the following rails, which are given in the order in which they may be set up:

2 guard rails marked (a) and (a′). (Fig. 17.)

1 frog (b).

2 connection pieces (c and c′). [If the rail back of b will be shorter than 10 ft., it is customary to take out another standard length rail and cut two connection pieces instead of one.]

2 lead rails (d and d′). [These may be shorter rails, or may be the same length as (e and e′).]

2 lead rails (e and e′).

Fig. 17—General Switch Layout for No. 10 or No. 11 Turnout with Square Joints.

2 switch rails (f and f′).

1 stock rail (g) and 1 main line rail (g′).

2 connection rails (h and h′).

Connection pieces (i and i′).

Rails (j and j′).

Rails (k and k′).

To put in a switch on a new track, or where there is no traffic to be delayed, set up the rails, etc., and bolt them together in the order a, b, c, d, e, f, g, h, i, j, k, g′, h′, i′. Then set up a′, c′, d′, e′ and f′. If the switch is put in under traffic one side at a time, set up a, b, c, d, e, f, g and h (for a right hand turnout), throw these rails in, and complete in the order given above. For a left hand turnout, put in under traffic, set up a′, b′, c′, d′, e′, f′, g′ and h′, throw them in and complete in the order i′, j′, k′, g, h, i, and then a, c, d, e, and f.

Laying Turnouts in Main Line, General Method—Turnouts or crossovers can be put in without delaying traffic, if the proper method is used. Even when the time available between trains is only 15 or 20 minutes, the work can be done with a fairly intelligent and willing gang, without delaying regular trains. Very thorough and systematic preparation is necessary, however, in a case of this kind.

The following order of work and general method should be used when (A) switch ties are to be put in at the same time and (B) rails must be moved so that joints will clear the switch point:

(1) Place out slow flag and flagmen.

(2) Mark frog point, heel of frog and switch point.

(3) Start stripping out ballast.

(4) Mark off center mark for each tie on the flange of the rail, and number each mark.

(5) Measure ties and start men cutting short pieces of rail for lead rails, if necessary, and for all connections ahead and behind switch.

(6) Measure ties, number them and start distributing them opposite corresponding marks on the rails.

(7) Start claw-bar men pulling spikes from every second tie on the outside of one rail and the inside of the opposite rail. Raise spikes on 6 or 8 ties each side of the switch.

(8) Starting at one end of the switch, place jacks under each rail, withdraw unspiked ties, and throw in every other switch tie, moving jacks ahead as necessary.

(9) Place switch slide plates under both rails.

(10) Start spikers spiking old rails to new switch ties (temporary spiking.)

(11) Double back of these spikers with claw-bar men, after they have pulled spikes on half of the old ties, and pull the spikes from the remaining old ties.

(12) Double back with jacks, after half the old ties have been removed and replaced with switch ties, and pull out the remainder of the old ties, then put in the rest of the switch ties.

(13) Space the ties.

(14) If rails must be moved ahead on straight or main

line side of the switch, remove a rail ahead or behind those within the switch; draw the inside spikes on the rails, break the joint back of the string of rails to be moved and move the rails away from the spikes; place the short connection rail (already cut) in the track, and launch the string of rails against the connection. Put in the connecting piece at the opposite end, bolt and spike up the rails.

(15) Set and spike the guard rail on straight side of switch.

(16) Set up and bolt together the frog, connection piece or pieces, and lead rails, on the ties.

(17) Bend the stock rail.

(18) Break the joint behind switch (and ahead if necessary), line out old rail for curved lead, and line in new rails and frog.

(19) Bolt the switch point to lead rails, place slide plates, gage and spike the rails safe for trains.

(20) Set up and bolt curved lead rails and switch point.

(21) Full spike the rails.

(22) Put on switch rods.

(23) Set switch stand.

(24) Fill in partially.

(25) Surface the switch.

(26) Line the switch.

(27) Spike-line the curved lead.

(28) Fill in and dress up.

(29) Drill the cut rails, and bolt in full.

(30) Clean and pile up neatly all material which remains.

Explanation of Steps Enumerated Above—If lead rails have to be cut, the one for the curved lead should be

made longer than the straight one. The difference in lengths of the lead rails may be obtained by dividing 12 in. by the number of the turnout.

The frog, connecting piece, main-track lead rails, switch rail and stock rail are set up in their proper order opposite the position they are to occupy. If set up within the track, these rails should be protected by riser blocks. Half the outside spikes are pulled from the track rails to be removed, the flagmen are sent out, the remaining outside spikes are pulled, and the first joint back of the frog point is broken. The track rails are shoved over to the ends of the ties and used for the turnout track. The connected parts are then slid in to take the place of the old rails. All spikes must be pulled out where the switch rail and frog are to lie. If a joint in the track will interfere with the switch rail, a new stock rail and connecting rails should be set up outside the track, and put in to replace the old rail ahead of the switch at the same time the frog is put in. Before spiking, the stock rail should be bent in the regular manner.

In case the rails on the opposite side of the main track must be moved ahead or back to make a joint clear the switch rail, the operation should be performed first so that the guard rail may be set before the frog is put in.

Before breaking track to put in a frog, the main-line guard rail should be correctly set up and spiked in place This reduces the work to be done when the track is torn up.

Measurements for the cut rail to be used behind the frog should be carefully taken with a steel tape line, if available. If a cloth tape line is used, its length should be checked by comparing with several standard length rails. The amount of expansion allowed for joints should

be governed by the expansion in the old track. If the track is tight, the rails may run as soon as the track is opened up and cause difficulty if the short piece is figured to make an exact fit. The cut rail can be drilled before breaking the track, and the frog and short piece bolted together. The joints must be bolted up in full immediately to prevent rails drawing apart, in case the track is loose. The track ties behind the frog should be adzed to permit the easy removal of the rail.

In placing the switch point, all the spikes are removed from that portion of the track rail against which the switch rail is to be placed. The joint at the heel location is broken and the end of the rail shoved outward to form the stock rail, or the old rail may be taken out entirely and a new rail used for a stock rail. The rail bender or jim crow is placed the standard distance ahead of the switch point and the proper kink given the rail. The switch rail is heeled up against the main track rail, and a rail for the turnout side is heeled in against the end of the stock rail. The angle bars, heel block and heel plate are then placed. In the meantime the slide plates are placed on the ties. The gage need only be used at the point and heel of the switch rail. Switch points should never be tight, and to avoid this it is advisable to have the gage a trifle wide, say $\frac{1}{8}$ in. After safely spiking the switch rail, frog and connection piece, and having previously set up and spiked the guard rail, the track is safe for traffic and the flagmen may be called in.

The three operations of moving the rails transversely, putting in the frog, and putting in the switch rail were discussed separately, but they can be done successively in the order named, or simultaneously, working on all of them at the same time.

It saves respiking and time to put in the slide plates on the main track side of the switch when temporarily spiking the old main line rails. A spike should be driven down about half way on the inside of each rail, beside the tie plate, to keep the rail from climbing up over the risers.

Slide plates are usually placed directly in the center of the tie in which case the tie will rock very easily since all spikes are in a line. A much better way to set tie plates, is to set one close to one edge of the tie and to set the plate on the opposite end close to the opposite edge. This arrangement approaches the standard for spiking an ordinary track tie and reduces the likelihood of rocking. The No. 1 slide plates should have holes drilled in them through which the point may be spiked closed when desired.

The curved lead switch point and lead rails can be put in place without breaking the main track, and no flag protection is necessary. For safety, switch rods should be put on as soon as the switch rails are both in. When moving rails out from under the spikes the shoulder on the tie should be adzed off to facilitate the easy removal and replacement of rails.

To set a switch stand on main line the following method should be used: Spike the No. 1 switch plates in place on both rails, leaving the track a little wide at the points, but not to exceed $\frac{1}{8}$ in., and spike the switch rail closed for the side track; connect up the stand, connecting rod, and No. 1 switch rod; place the switch stand parallel with the track, with the handle in a position corresponding to that of the closed switch point; hold the switch stand with a bar and spike it down so that there is no lost motion on the closed-switch-point side;

remove the spike from the switch point, raise the handle of the switch stand and, using a bar, throw the switch rails over against the opposite rail; then adjust the No. 1 rod so that the switch handle will drop snugly into the slot. Switch points should fit snugly against the rail when thrown over, but a very tight fit is undesirable, as some part of the device will have to be sprung when thrown.

The switch stand with an adjustable movement for use with a rigid or non-adjustable switch rod, is rapidly gaining in favor. The rigid rod is made for the correct gage, and all adjusting is made in the stand or connecting rod.

The curved lead of a switch is usually spike-lined by eye from the heel of the switch rail to the toe of frog, although it is sometimes possible to obtain the correct distances (called ordinates) from gage of main track to gage of lead rail, at certain intermediate points on the lead. Before lining the turnout rail, the tangent or main line rail should be lined up correctly. Otherwise when lining the main track later, the line of the turnout track will be spoiled.

All ties should lie square across the track. This is especially true of head-block ties, because the connecting rods must be perpendicular to the track to prevent binding and to make the switch throw easily. Stock rails should be standard length rails, so that they may be replaced by new ones without cutting. The gage at the point of switch or point of frog should be a little loose rather than tight.

Before leaving a newly constructed switch in main track, it should be put in good surface and line; both guard rails should be set, bolted and blocked; all rails should be drilled, full bolted and full spiked; frog and

switch points should be completely blocked with foot guards; the switch stand should be correctly set and locked. If the turnout side is ready to be used, all spikes should be removed which will prevent switch points, movable frog points or the spring rail of a frog from moving, and all excess material should be loaded or neatly piled up.

Putting in a No. 10 or No. 11 Turnout—The following program may be used for putting in a No. 10 or No. 11 turnout when (A) the old track rails can be used for stock and lead rails, and (B) the frog can be located so that it will toe-in against one of the track joints. (See Fig. 18.) The order of work is as follows:

(1) Put in switch ties as described above, but do no unnecessary spiking.

(2) Cut connection rail (c) to go behind frog.

(3) Set guard rail (a).

(4) Remove part of spikes on one side of rail where frog is to be placed; partially break the two joints on this rail.

(5) Set up on the end of the ties and bolt together the frog (b) and connection rail (c) opposite correct position in track.

(6) Send out flagmen.

(7) Pull the rest of the spikes, break the joints, and throw out old rail.

(8) Line frog into place, bolt up joints, gage and spike frog.

(9) Place slide plates under rail which is to be bent for stock rail.

(10) Break joint at heel of switch rail and bend stock rail.

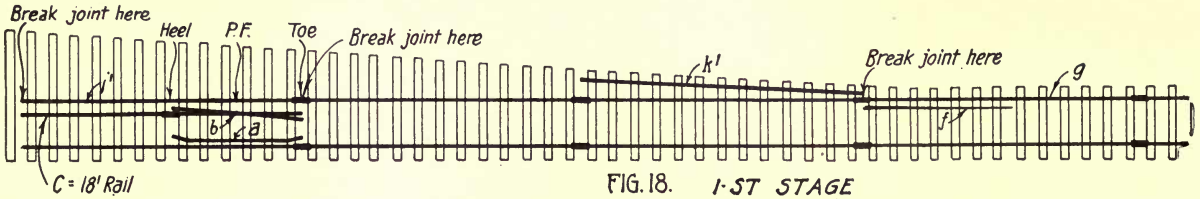


FIG. 18. 1-ST STAGE

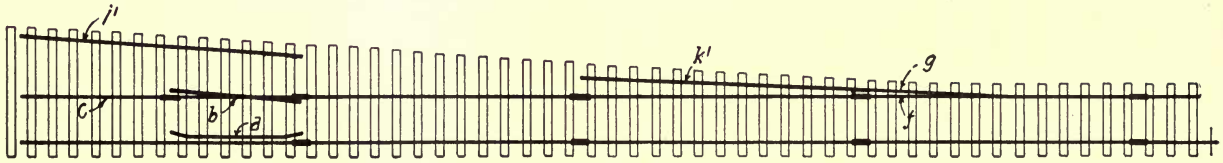


FIG. 19. 2-ND STAGE

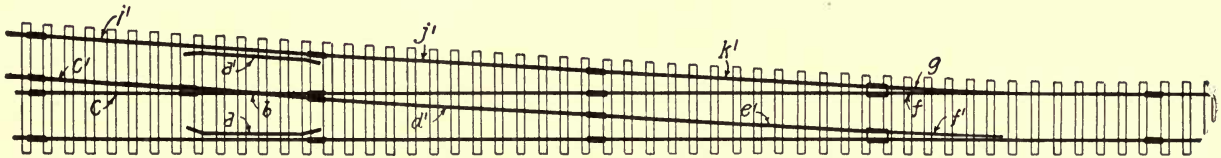


FIG. 20. 3-RD STAGE
Completed Switch

Figs. 18, 19 and 20—Putting in No. 10 or No. 11 Turnout in Square-Jointed Track Using Old Rails for Lead Rails, Frog Located with Toe at a Joint.

(11) Place switch point (f) against the end of lead rails, and bolt up.

(12) Spike switch plates, gaging at heel and point of switch rail.

The rest of the work is similar to numbers 20 to 30 under the general method given above. This is the easiest way of putting in a No. 10 or No. 11 turnout where the existing track rails are standard 30 or 33 ft. lengths, the old track rails being used for the main line leads. Two of these rails with a frog 15 ft. long (toe from 8 to 9 ft.) and a 15 or 16½ ft. switch rail make an excellent lead without requiring any cut rails. The switch must be located so that the frog will toe-in at one of the main line joints. It is generally possible to locate the frog in this manner for a turnout, and for at least one end of a crossover. The frog of the second switch of a crossover must be located the standard distance from the first (see table in Appendix) so that the track between the frogs will line up correctly.

If it is necessary to move the rails on the main-track side of the switch, a standard length rail should be cut in two, a rail taken out immediately ahead of the switch and the rails within the switch location loosened and launched forward against one of the cut pieces. The remaining piece, used behind the string of rails moved, will close up the hole.

Method No. 1 for Laying No. 10 or 11 in Main Line—In Figs. 18, 19 and 20 there is illustrated a method of putting in a No. 10 or 11 turnout where (1) the main track has square joints; (2) standard length track rails (30 or 33 ft. long) are used in the leads; (3) the switch is located so that the frog toes-in against a rail joint;

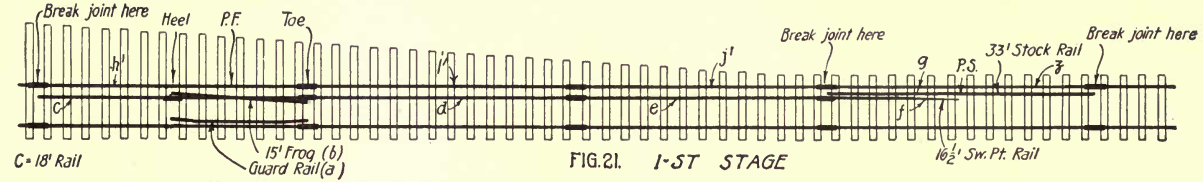


FIG. 21. 1-ST STAGE

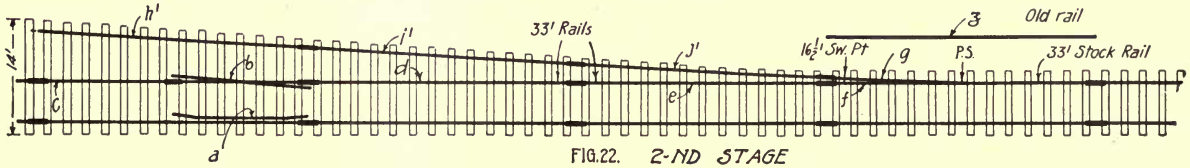


FIG. 22. 2-ND STAGE

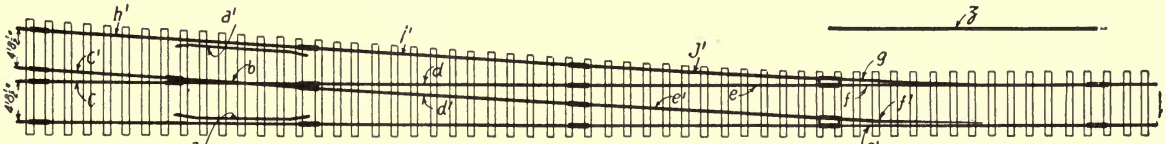


FIG. 23. 3-RD STAGE
Completed Switch

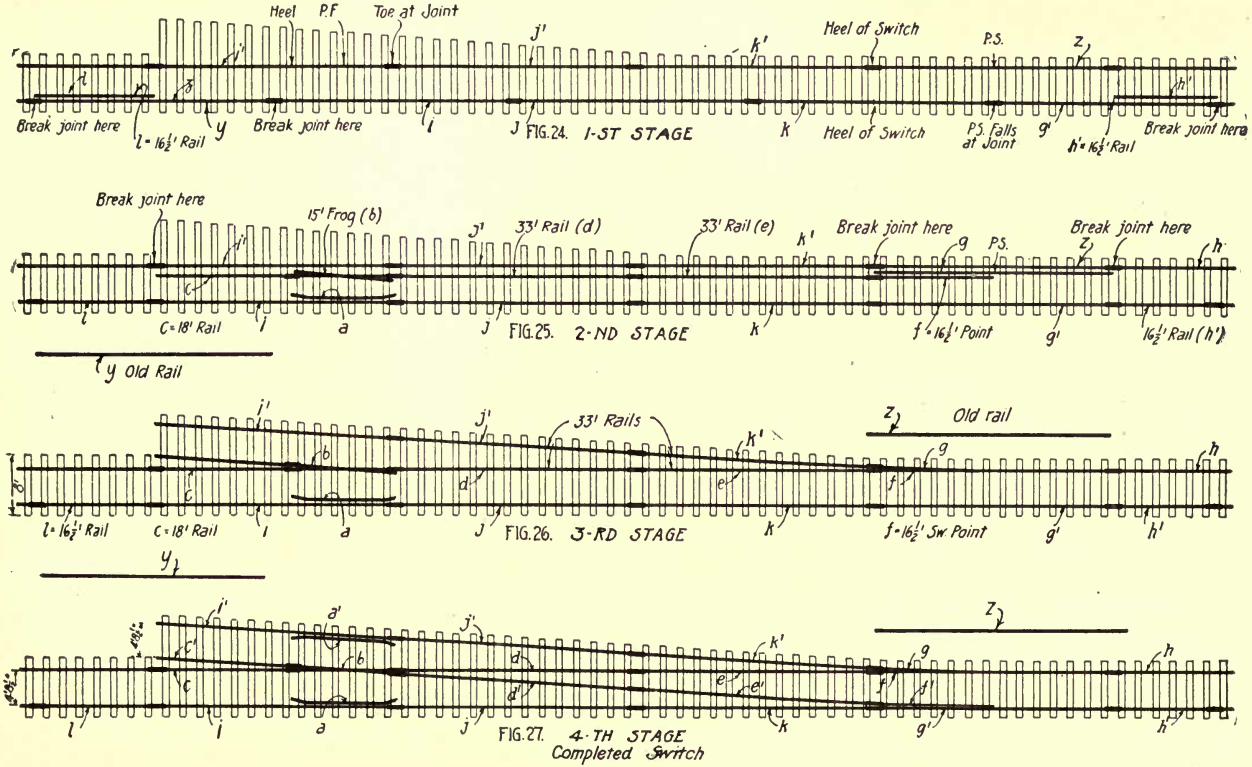
Figs. 21, 22 and 23—Putting in a No. 10 or No. 11 Turnout where Frog Toes-in at a Joint, Old Rails Are Lined Over for Curved Track and No Movement of Old Rails Is Necessary to Make Switch Point and Guard Rail Clear the Joints.

(4) the main line rails can be used for main-track lead described.

The different parts of the switch in the diagram are lettered in the order in which they should be put in, in general, first (a), then (b), then (c), and so on. As shown in Fig. 18 the first step is to set the guard rail (a), cut the connection rail (c), bolt it to the frog (b) and break the three joints as shown. The second step, Fig. 19, is to pull the necessary spikes and take out the rail (i'), throw the frog and connection rail to place and bolt up and spike them, bend the rail (g) at a point 12 to 16 in. ahead of the point, making it a stock rail, and bolt the switch rail to the main track rail. The third step, Fig. 20, is to set up the point (f'), lead rails (d') and (e'), rails (c'), (j') and (k'), and set and spike guard rail (a'). The detail work of putting in plates, setting switch stands, etc., is similar to that described before.

Method No. 2—The problem in Figs. 21, 22, 23 is to put in a No. 10 or 11 turnout when: (1) The main track is laid with square joints; (2) the lead rails are standard length track rails (30 or 33 ft.); (3) the frog toes-in at a rail joint; (4) main line rails are thrown out for use in curved turnout track; (5) the stock rail is a new rail; and (6) all joints must square up at the heel of switch point rail.

The diagram of this switch is lettered similar to the preceding figures and the order of setting up the different parts is nearly according to alphabetical order. In the first stage the guard rail (a) is placed; frog (b), short rail (c), lead rails (d) and (e), switch point (f) and



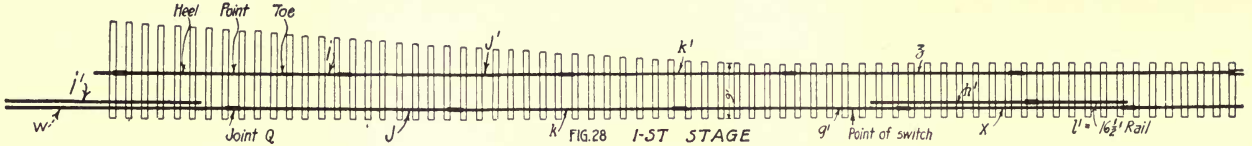
Figs. 24, 25, 26 and 27—Putting in a No. 10 or No. 11 Turnout in Broken-Jointed Track where Rails on Outside of Turnout Must be Moved to Make Joint Clear Switch Rail; Toe of Frog at Joint in Old Track.

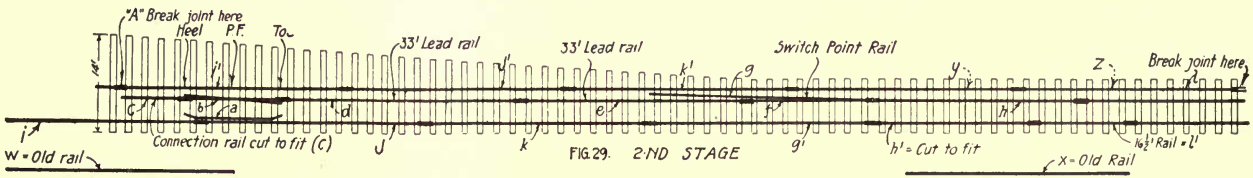
stock rail (g) are then set up and bolted together. Three joints are broken as shown, after pulling necessary spikes. The old rails are then thrown out, and the switch point and lead rails, frog and connection rails are thrown in and are spiked as shown in Fig. 22. The lead rails (d′) and (e′), and switch point (f′) are set up, bolted, lined and spiked. The curved rails (h′), (i′) and (j′) are gaged and spiked, and the guard rail (a′) is set. In some cases it may be advisable to put in a new rail at (j′).

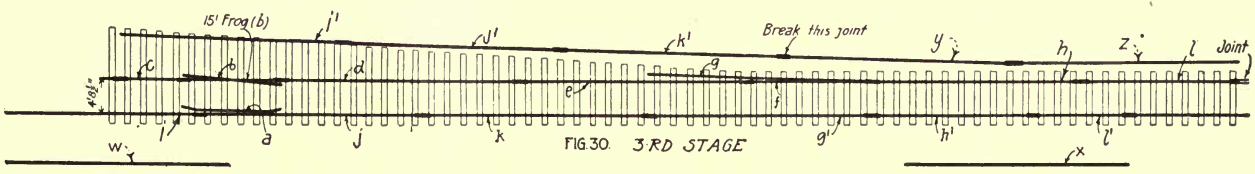
Method No. 3—In method No. 3 the conditions are as follows: (1) The main track is laid with broken joints; (2) the lead rails are standard length rails (30 or 33 ft.); (3) the frog toes-in at a rail joint; (4) main line rails are thrown out for use in curved turnout of track, and the stock rail is a new rail; (5) all joints square up at heel of switch point rails.

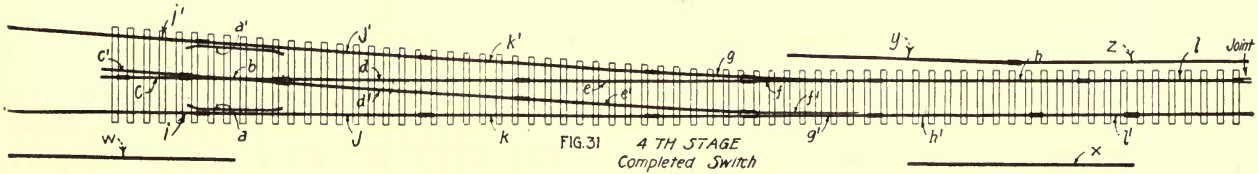
In Fig. 24 the first step is to cut a rail in the middle, giving two 16½ ft. pieces, (h′) and (l). Joints are broken as shown, rail (y) is removed and (l) put in place. Spikes are pulled from rails (i), (j), (k) and (g′) and they are moved ahead against (l); then rail (h′) is set up and bolted and spiked.

In the second step, Fig. 25, the guard rail (a) is set, frog (b), connection piece (c), lead rails (d) and (e), switch point (f) and stock rail (g) all are set up and bolted together, the stock rail having been bent previously. Joints are broken as shown and in the third step, Fig. 26, rails (i′), (j′), (k′) and (z) are thrown out and the new ones thrown in, then bolted and spiked. Guard rail (a′) is then set up and spiked. The lead rails (d′) and (e′) and switch point (f′) are set up (Fig. 27), bolted, lined and spiked. Curved rails (i), (j) and (k) are gaged and spiked and guard rail (a′) is set.









Figs. 28, 29, 30 and 31—Putting in a No. 10 or No. 11 Turnout in Broken-Jointed Track Where Toe of Frog Cannot be Located at a Joint in Old Track.

Method No. 4—Method No. 4 is applicable for putting in a No. 10 or 11 turnout when: (1) The main track is laid with broken joints; (2) the lead rails are standard length track rails (30 or 33 ft.); (3) the switch is to be laid with broken joints; (4) the track joints must be located at least 6 ft. back of the heel of the switch point rail.

The first step, Fig. 28, is to cut a 16½ ft. rail (i′) and to cut (h′) of such a length that it will throw the joint (q) back to clear the guard rail (a); (i′) is cut so that when the rails are launched back to put in (h′) and (l′), joint (q) will set against rail (i′). The joints are then broken as shown, spikes pulled, and rails (w) and (x) thrown out. The connection piece (i′) is put in, rails (j), (k) and (w) moved ahead against (i′), the rails (h′) and (l′) inserted and bolted up and spiked. In the second step, Fig. 29, guard rail (a) is set, connection rail (c), frog (b), lead rails (d) and (e), switch rail (f), stock rail (g), track rail (h) and connection rail (l) are set up and bolted.

Joints are broken as shown in Fig. 30, in the third step, spikes are pulled and rails (i′), (j′), (k′) (y) and (z) are thrown out and the part of the switch setting on the ties is thrown in, bolted up and spiked. In the fourth step, Fig. 31, lead rails (d′) and (e′), switch point (f′) and connection rail (c′) are set up, bolted, lined and spiked. Rails (i′), (j′) and (k′) are moved ahead, set up, bolted, gaged and spiked. Guard rail (a′) is then set up. Detail work is the same as described heretofore.

Temporary Switches—Ordinary track ties interlaced do not make an advantageous arrangement even for a temporary switch. Hewn ties used in this manner require much difficult adzing to obtain an even bearing

for each rail. Even if sawed ties are used throughout, they will be warped enough to require a lot of adzing, and the ties will generally be so closely interlaced that it is practically impossible to do any surfacing or tamping. When no switch ties are available, however, track ties will have to be used and interlaced in a manner to provide adequate support and enough spiking to hold the track to gage.

A temporary switch should be located in a manner to cause the least disturbance to permanent track or other structures, and so that when the switch is taken out, the track can be easily replaced, without cutting rails. Track joints should not come between the point and heel of the switch rails for if they do the switch point will not fit up tight. A temporary switch should if possible be located so that no track rails will have to be moved transversely in order to make the joints clear the switch point; for this requires that an extra rail be cut and two short pieces used in the main track instead of one. If no transverse movement of rails is necessary, when the temporary switch is removed the track can be again made continuous by inserting the old main line rails previously used in place of the frog and connecting rail.

Having decided on the proper location of the frog point, the switch should be laid out; that is, the location of the switch and frog points marked on the existing rail. It is well to bear in mind that considerable variation of the switch lead (say 10%) is allowable and even advisable in temporary switches to facilitate the work or reduce the cutting or movement of rails. In permanent work the lead should not be reduced more than 5%.

If the frog and switch points are new, the stock rails and connection rails back of the frog should also be new; however, if the main-track rails are not worn down or battered much (in other words, if they are practically as good as new) they may be used instead of new rails. A worn rail placed against a new frog, or vice versa, makes a bad joint and allows the frog or rail to be battered and spoiled.

In laying temporary switches it is generally possible and advisable to omit heel blocks, frog blocks and guard-rail blocks with the possible exception of those on the guard rail for the curved lead. This does not refer to foot-guard blocks which should never be omitted. One hole should be sufficient in the cut rails. If slide plates to complete the set for a temporary switch are lacking, the number used may be reduced to one-half or more with safety if the switch is to be subjected only to the traffic of light engines and slow speeds.

The method of putting in the switch points, lead rails and frogs of a temporary switch does not differ materially from the method of putting in permanent turnouts, except that the quality of the work need not be so high.

The No. 1 or adjustable rod furnished for a temporary switch is likely to be an old one and badly rusted. It may be impossible to adjust it if it is the old screw adjusted type; but it is usually permissible to use a rod for a temporary switch in a side track which leaves the gage say a half inch wide. Narrow gage is unsafe at a switch point, as it may result in wheel flanges climbing up on a switch rail. If the switch rod will not make the gage at the switch point more than a half inch too wide the following method of setting a stand may be

used with a rod which cannot be adjusted: Connect up the switch stand, connecting rod, and No. 1 rod; throw the switch point against the main-track stock rail with a bar and spike it in this position, having previously spiked the No. 1 switch plate in place on the same side. The switch stand should now be lined up parallel to the track with the target showing correctly for the closed point, and with the handle in its correct position. The stand can be spiked solidly in this position at the same

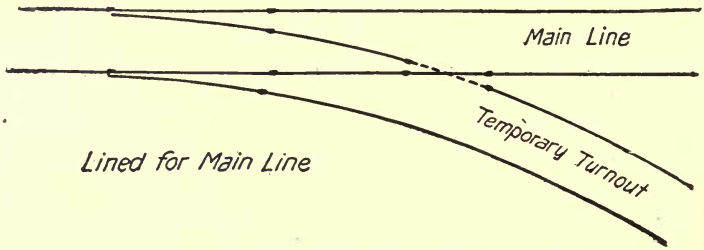


Fig. 32—Turnout Without Frog or Points—Lined up for Main Line.

time taking up all lost motion; the spike holding the switch point can now be removed and the opposite point thrown over against the unspiked rail, the handle of the switch stand moving at the same time far enough to drop into the next slot. The *track rail* should then be held tightly against the *switch point* and spiked in that position, at the same time inserting the other No. 1 switch plate and making sure that the spike on the opposite side of the tie is well up against the stock rail. The switch points will now close on either side, and although the gage will not be exact it will be close enough for temporary work. The remaining switch plates may be placed without gaging, if the heel and point of the switch rail has been gaged. After putting on slide plates

on one end, the switch ties are likely to move lengthwise and drop away from the rail when an attempt is made to spike the opposite end. To prevent this, two nippers should be provided and the spiked end of the tie should be nipped up first, and held while the unspiked end is brought up.

It is a very difficult matter to procure men who will not take too much pains with temporary work. It is apparent, however, that a piece of work which is to last

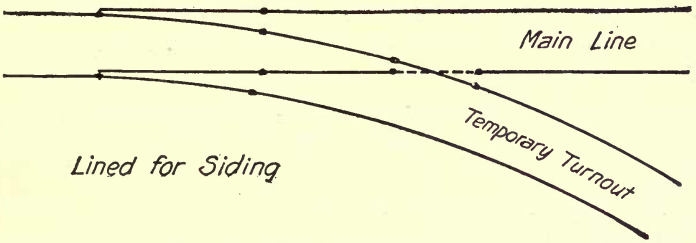


Fig. 33—Turnout Without Frog or Switch Points—Lined up for Siding.

for a few months only does not require as good work as one which is to remain for years.

Turnout Without Frog or Points—A turnout without frog or points was described by Andrew Palm, roadmaster, C. C. T. Co., in the January, 1914, issue of Railway Engineering and Maintenance of Way. This switch is similar to the old style stub switch with the frog and guard rails omitted. It is undesirable to place switches in main line except where absolutely necessary, and quite frequently one of the temporary turnouts illustrated in Figs. 32 and 33 is better adapted to the purpose than the standard switch and frog turnouts. From a safety standpoint it is an ideal layout, and it can be constructed for less than half the cost of the standard point switch.

Where main lines are laid with broken joints, two

half-rails are used, one to even the joints at the point where the turnout begins, and the other at the place where the frog would be placed in a standard lead. When it is desired to put a train on the siding, the spikes are pulled, the two joints of the half-rail are taken off, and the rail swung into the open space in the turnout. The half-rail is then bolted up and a few spikes driven if necessary. All that is required at the stub rail is to remove the angle bars from the main-line joint, and a few spikes from the inside of one rail and the same number of spikes from the outside of the other. The rails are then thrown over with a bar and angle bars put on temporarily. This arrangement has the advantage of keeping the main track closed when the turnout is not in use.

In construction work this layout is found very useful, as sidings must often be constructed for track laying and surfacing gangs. When short of frogs and switches, these turnouts may be put in at points where permanent turnouts are to be located, and upon the arrival of the frogs and switches the standard turnouts can be installed.

Without this or a similar device material trains might sometimes have to go 15 or 20 miles to pass each other, while with it the empty train takes siding and allows the loaded train to proceed to the front. Trains can be passed with only two track men—an assistant foreman and one laborer, to make the changes.

McAndrews Method—J. P. McAndrews, roadmaster of the Chicago and North Western Ry., uses the following inexpensive method for spurring out cars, to prevent breaking the track, disturbing the roadbed, or trouble caused by rails expanding while track is open. Instead of

a frog, a short piece of rail is used with the base and web (but not the ball) cut out at the middle so it may be set over the main-track rail. This rail is bent in a vertical curve so that the ends will rest on the ties. The wheel flanges are thus carried up over the main track rail when

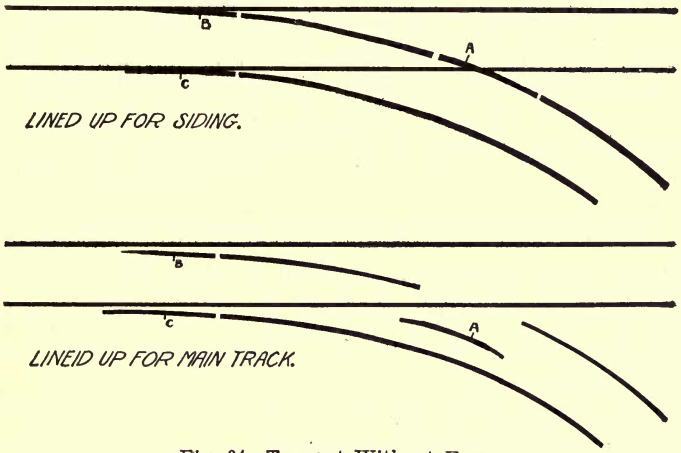


Fig. 34—Turnout Without Frog.

A is a 15 to 16 ft. rail curved vertically, with base and web cut out so that it fits over the top of the main line rail, taking the place of a frog.
B is a standard switch point rail.
C is a rail bent vertically to raise the flange over the main line rail as the train runs onto the siding.
The lead is spiked in place permanently, but rails A, B and C have to be moved in and spiked when the train runs in on the siding. When the switch is not in use, the rail A is taken out and laid to one side and B and C are spiked solidly away from the main track rail.

going in onto the siding. The short piece of rail has to be placed and bolted each time the switch is lined up for the siding. (See Fig. 34.)

Instead of cutting the track at the switch points a riser rail is used on one side and a point on the other, as in the Wharton-type switch.

Spurring Out Cars—The writer was once instructed to spur out one car, an outfit for 8 foreigners, using the

ordinary method of stripping out and lining over the track. On investigation the ties in the main track were found to be decayed so badly that they would have had to be replaced if dug out, lined over, and lined back

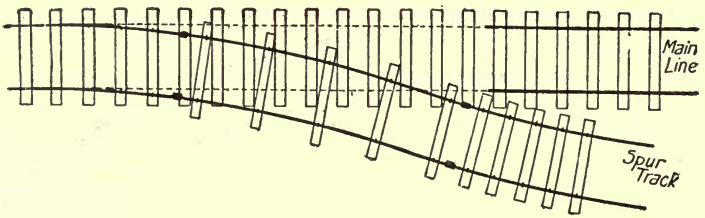


Fig. 35—Method of Spurring Out Cars Without Moving Track Ties.

again. The construction forces naturally did not care to renew ties for 60 ft. of track, just to spur out a single car, especially since the ties, if undisturbed, would last for a year or more.

The sketch, Fig. 35, shows the method used. The spikes were pulled, the rails lined over and connected to the temporary track with angle bars, and spiked. Enough short ties were laced in to hold the track to gage. The temporary track was laid and spiked up, measurements being carefully made so that when the track rails were lined over, the joints were easily made by bunting the temporary rails back a little.

A locomotive should not be pushed in on a curve of this kind, which is usually pretty sharp. The best arrangement is to have a number of light empty flats between the locomotive and car or cars to be spurred out. The flat cars are not nearly so likely to spread the rails or get off the track as a locomotive.

With a well trained and organized gang, 3 or 4 cars

may be spurred out in this way and the track closed in 10 minutes, after thorough preliminary preparations have been made.

Stripping the ballast from between the ties and lining over the track, ties and all, is a poor method, and besides taking more time, it disturbs the old road bed, leaving it soft so that the track soon settles out of surface.

Constructing a Ladder Track—In laying a ladder track, the gang should be organized so that few changes in the disposition of the men are necessary to keep the gang compact, and to leave each part of the work completed.

The following organization is suggested for a gang of 40 laborers.

Rail cutters.
Tie line man and fiddler.
Tie spacers and liners.
Rail and frog gang.
Spike, bolt and angle bar peddlers.
Bolters.
Spikers.
Nippers.
Gang setting guard rails.
Gang setting switch stands and spiking around switch points.
Drill gang.
2 assistant foremen.
1 foreman.

The second assistant foreman should measure up and mark the switch ties, have them distributed in correct order and lined and spaced. The first assistant, who is given charge of setting up the rails, frogs, and switch rails, should be an experienced track man. Careful work on his part in the use of different lengths of rails as furnished, on the straight side of the ladder, will greatly reduce the number of rails to be cut. The foreman should take direct charge of the men setting switch

stands, guard rails, etc. The spacing for ladder-track frogs is given in a table in the Appendix.

One party of men should be started cutting rails, and should be kept busy at such work until lead rails are ready for the whole ladder. Each switch should be set up independently, no attempt being made by the assistant foreman to cut-in the connections back of the frogs. After two or three switches have been set up, the men cutting rails will probably have enough lead rails ready so that they can start cutting-in the connection rails behind the frogs. This work, including measuring the holes and marking the rails, can be taken care of by an intelligent laborer with one assistant. If there is no man who can be trusted with such work, the foreman will have to measure and mark all the rails. The men cutting rails should be able to set them in place, and bolt them ready for spiking and still keep up with the gang. With the above organization it is possible to average a No. 7 or No. 8 switch per day or even more for every ten men.

Putting in switches calls for high organizing ability. It is seldom that a gang is kept constantly on this sort of work, and if a man is slow in perfecting his organization the switch work is likely to be all done before the gang attains any degree of efficiency. The qualifications for a foreman for a switch gang are ability to rapidly organize and discipline a gang of men. A foreman of exceptional ability is required to lay a ladder track correctly, rapidly, and economically.

A good switch must have plenty of ties under the frog, the head blocks must be square across the track and the rails must be full drilled, bolted and spiked. It is necessary to watch carefully the sizes of rails set up if sec-

ond-hand rails are used, for there is a chance for some confusion between sizes which vary little in appearance. The use of a wrong size rail is likely to cause derailment, particularly if stock rail and switch rail are not the same size, in which case the switch point will not fit up correctly.

Crossovers—Putting in a crossover is about the same as laying two turnouts. The proper distances between points for crossover frogs of different angles are given in a table in the back of the book. Before starting work, the foreman should carefully measure the distance between the stakes for the two frogs of the crossover, as well as the track centers, to be sure these are correct, before he starts work on the second switch. If the correct distance is not left between the frogs, the track will not line up correctly between them.

First-class work only should be allowed in main line crossovers. Care should be exercised in: (1) Checking up and correcting frog point locations; (2) gaging exactly throughout; (3) surfacing and lining main line track before lining curved leads. The requirements for good work here are the same as those given for a ladder track, but the work should be even better than that done in a yard.

Lining the curved leads by eye sometimes results in badly mutilating the ties, before the rails are finally spiked in proper position. All leads should be lined by ordinates, and for this purpose a table of ordinates is given in the Appendix.

CHAPTER VII.

SLIP SWITCHES.

What a Slip Switch Is—A slip switch looks very complicated yet it consists simply of either one or two Y-track connections, and two tracks which form an ordinary track crossing. The elements of a slip switch are shown in Figs. 36, 37 and 38. Fig. 36 shows an ordinary track crossing; the addition of the curved Y-track rails (e) and (g′), Fig. 37, transforms the crossing into a single

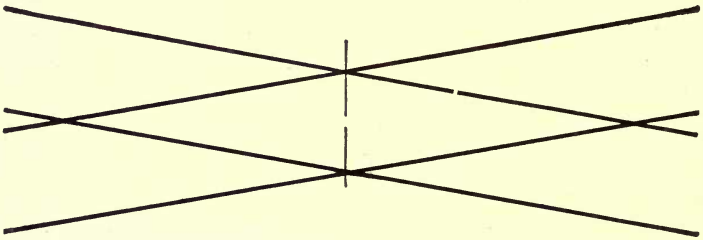


Fig. 36—Elements of Slip Switch—An Ordinary Crossing.

slip switch. In Fig. 38 curved Y-rails (e′) and (g) are added, making a double slip switch.

The spacing of ties for a slip switch should be accurate, the exact centers shown on the detail plan being strictly adhered to. Ties are designed to support certain plates, which in turn are designed for certain points in the switch. If plates are not placed correctly they will not fit, and it will be impossible to bring the rails to correct gage. Ties should be lined by using a rope or cord stretched on the center line of the switch, from frog point to frog point, and not from a line stretched

for the ends of the ties. Each tie must be measured and its center marked. Ties should be laid at right angles with the center line, and not at right angles to either track.

A very accurate way of spacing ties is to measure

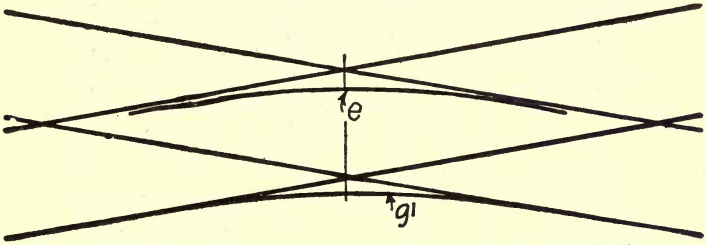


Fig. 37—Ordinary Crossing with One Y-Track Added—Making a Single Slip Switch.

from the center line of the switch to the center line of each tie. For this purpose the author worked up a table, Fig. 39, showing these spacings for a C. & N. W. Ry. standard No. 8 double slip switch. By using such a

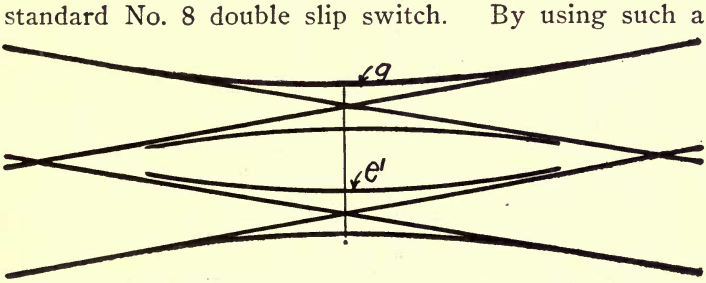


Fig. 38—Ordinary Crossing with Two Y-Tracks Added—Making a Double Slip Switch.

table, the center for each tie may be measured independently of all others, preferably using a steel tape line. In this manner cumulative errors will be eliminated. In other words, one wrong measurement will not cause all the center marks beyond it to be wrong.

TIES			DISTANCE CENTER LINE OF TIE TO CENTER POINT OF SWITCH	PLATES	
NO	LENGTH	SPACE			
1	11	$9\frac{1}{2}$"	$9\frac{1}{2}$"	2 No 19	
2	11	1'-11"	2'-$8\frac{1}{2}$"	2 " 18	
3	11	1'-$7\frac{1}{4}$"	4'-$3\frac{3}{4}$"	2 " 17	
4	11	1'-8"	5'-$11\frac{3}{4}$"	2 " 16	
5	11	1'-9"	7'-$8\frac{3}{4}$"	2 " 14	
6	11	1'-9"	9'-$5\frac{3}{4}$"	2 " 14	
7	11	1'-9"	11'-$2\frac{3}{4}$"	JOINT	
8	11	1'-6"	12'-$8\frac{3}{4}$"	"	
				OUTSIDE RAIL	INSIDE RAIL
9	11	1'-$7\frac{1}{2}$"	14'-$4\frac{1}{4}$"	2 No 10	2 No 11
10	11	1'-$7\frac{1}{2}$"	15'-$11\frac{3}{4}$"	2 " 9	2 " 12
11	11	1'-$7\frac{1}{2}$"	17'-$7\frac{1}{4}$"	2 " 8	2 " 11
12	11	1'-11"	19'-$6\frac{1}{4}$"	2 " 7	2 " 13
13	12	1'-$6\frac{5}{8}$"	21'-$0\frac{7}{8}$"	2 No 5	
14	12	1'-11"	22'-$11\frac{7}{8}$"	2 " 4	
15	12	1'-6"	24'-$5\frac{7}{8}$"	2 " 3	
16	12	1'-11"	26'-$4\frac{7}{8}$"	2 " 2	
17	12	1'-$9\frac{1}{2}$"	28'-$2\frac{3}{8}$"	2 " 1	
18	12	1'-$3\frac{5}{16}$"	29'-$5\frac{11}{16}$"		
19	12	1'-4"	30'-$9\frac{11}{16}$"		
20	12	1'-4"	32'-$1\frac{11}{16}$"	JOINT	
21	12	1'-6"	33'-$7\frac{11}{16}$"	JOINT	

Fig. 39—Table Showing Tie Spacing for No. 8 Double Slip from Center Point to One End of Switch.—Same Spacing Used for Opposite Half of Switch.

In measuring off and laying out the work, measurements should always be made from the center point of the switch. The distance from center point to heel of frog should be marked on the rail, and then the rails may be cut for the connections. If nothing better than a cloth tape is available, it should be compared with several standard length rails, and if it is too short or too long the proper point should be marked on the tape for a correct rail length and this mark used in laying out the work. Or the slip switch rails may be measured as they are to be located in the track, using the defective tape line, and making the measurements on the rails in the track the same.

If a foreman is unfamiliar with the work, it is advisable to set up the slip switch in the material yard, fitting up each frog and rail as it should go. A few ties can be used as stringers to set the slip switch on, and this precaution may save hours and possible train delays when the work is being put in.

Method of Putting in a Slip Switch—One of four general methods of putting in a double slip switch may be used: (1) Send out flagmen, tear up track, replace old ties with switch ties, and set up the switch. (2) Put in switch ties, set up the switch and bolt together complete on stringers outside of the track rails, take out the track rails and line in the switch complete as a unit. (3) Put in the switch ties while the track is being used, set up the switch in halves, on the ties, on opposite sides of the track, and line into place one side at a time after taking out the track rails. (4) Set up the slip switch on the ties, bolt and spike in the material yard, place on a flat car with a locomotive crane, transport to the location where

it is to be put in and place in position with a locomotive crane.

The first method should be used where there is no great objection to closing the track to traffic for a half a day or more. It is probably the cheapest way, especially since traffic will cause no delay in the work. The second method requires a good deal of room outside the track. The third or the fourth method can be used in busy congested locations where time and space are at a premium. The third method will work out very satisfactorily for almost any conditions that have to be met.

Setting Up a Slip Switch—A No. 10 movable-point frog, double slip switch, Fig. 40, consists of the following rails, which are named in the order in which the switch may be set up:

2 middle stock rails marked (a) and (a′).

2 No. 10 frogs marked (b) and (b′).

4 short length straight rails, 2 marked (c) and 2 marked (c′).

4 movable frog points, 2 marked (d) and 2 marked (d′).

2 curved rails marked (e) and (e′).

4 curved switch rails, 2 marked (f) and 2 marked (f′).

2 curved rails marked (g) and (g′).

4 stock rails, 2 marked (h) and 2 marked (h′).

4 straight switch rails, 2 marked (i) and 2 marked (i′).

4 guard rails, 2 marked (j) and 2 marked (j′).

The rails marked (k) and (k′), are cut to fit behind the frogs, and (l) and (l′) are cut to fit behind the stock rails.

Tie Plates—After the proper locations of the rails have been mastered, the proper location of the plates must be

studied. The types and styles vary. It is quite usual to use gage or continuous plates under frog and switch point rails. In automatic signal territory gage plates may be cut in two to prevent electrical connections between the rails; or the plates may be made in two pieces and joined together with insulation between them. Sometimes, however, the entire switch is cut out of the signal circuit, so that neither of the above arrangements is necessary. In order to get the plates right, it is advisable to take a complete set and distribute them in the position shown in Fig. 41. Or half of them may be laid out on the ground at each end of the ties in proper order. For instance, if there are four plates on one tie, two plates should be placed at each end of the tie, with the one which goes in the center nearest the tie and the one for the outer rail beyond.

As many of the plates look almost alike, there is danger of putting some of them on the wrong ties, or under the wrong rail on the right tie. This not only causes additional work, but makes additional spike holes in the tie. Fig. 39 shows a table made up to indicate just what plates go on each tie and Fig. 41 shows a method of laying the plates on the ground and lining them up in the relative positions they will occupy in the switch, the light lines indicating bases of the rails. If the plates are laid out in this manner there is little chance of error when they are put on the ties.

A still better way to handle the tie plates is to spread them out in their correct order and then lay them down between the ties so that after the slip switch is thrown in, all that has to be done is to raise the rail and slip the plate under, the plates being placed so that there is little possibility of the men getting them on the wrong ties.

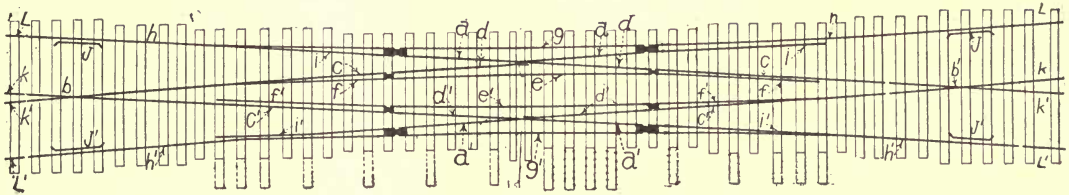


Fig. 40—Double Slip Switch Lettered in the Order in which the Rails Should be Set Up.

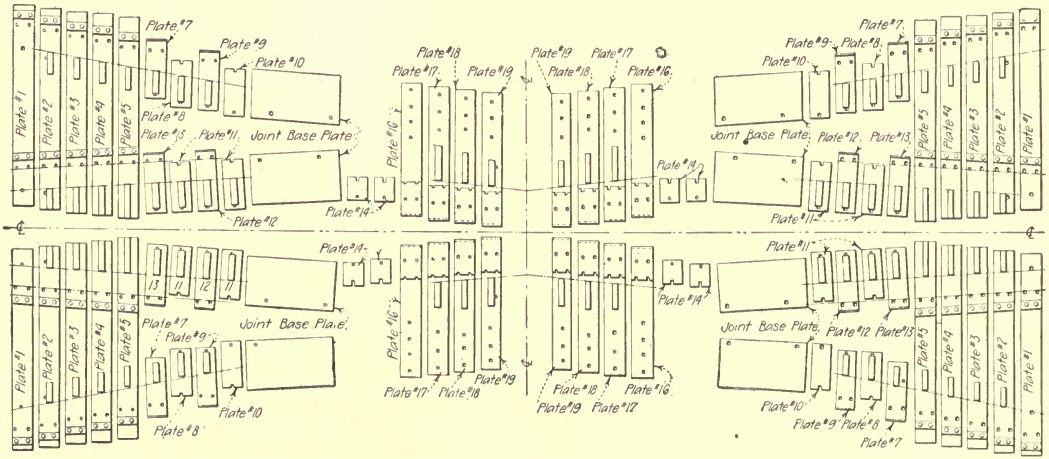


Fig. 41—Plates for Double Slip Switch Laid Out in Order in which They Occur in a Typical No. 10 Double Slip Switch; Light Lines Indicate Position of Edge of Rail Base.

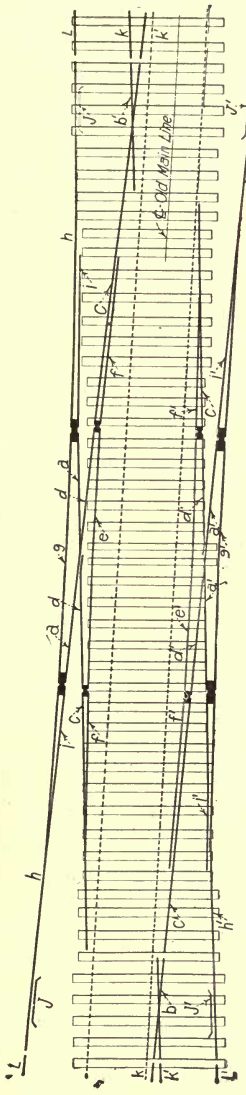


Fig. 42—Double Slip Switch Set Up in Halves, One Half on Each Side of the Track; Ready to Put in One-Half of Switch at a Time.

Putting a Double Slip Switch in One Side at a Time—When putting in a slip switch one side at a time under traffic, it is advisable to put the switch and frog point plates on the ties under the old track rail. The main track connection rails behind frogs, should be cut before breaking the old track. The track should be put in perfect line before tearing up to put in the switch.

One half of the switch is set up on the ends of the switch ties outside of one track rail (see Fig. 42) and the other half of the switch is set up outside the other. Rails a, b, c, d, e, f, g, h, i, j, k and l from the center of the switch to the *left* end of the drawing form a quarter of the layout. Rails a, b, c, d, e, f, g, h, i, j, k and l from the center to the *right* form another quarter, completing a half of the switch as shown on the upper half of the drawing. The same order is followed on the opposite

side of the track, that is, the lower side of the drawing. Rails a′, b′, c′, d′, e′, f′, g′, h′, i′, j′, k′, and l′ to the left are set up and the same order is followed on the right.

The middle points of rails (a, a) and (a′, a′) must be accurately at the center stakes. If two stakes are provided, a string may be stretched between them, and the center points, which are indicated by punch marks on the rails, should be located exactly under the string. If this is not correctly done, trouble will be experienced in getting the switch connected up.

After having the switch set up outside the track all but about six spikes per rail length can be pulled, which leaves enough to carry traffic at reduced speed. Flagmen are then sent out, and the joint spikes are pulled. If the preliminary work is carefully and completely done, and if all other necessary material such as bolts, spikes, etc., is handy, one side of the slip switch may be thrown in and spiked for a train in 30 minutes or less, with a competent, experienced foreman and a large gang of experienced men. The writer has seen one side of two slip switches connected by about 150 ft. of track thrown into place and a train pass over in 22 minutes from the time the order was given to tear up.

The method in detail for putting in one side of the switch is as follows: The flagmen are sent out and the spikes left in the preliminary work are pulled on one side of the track. The rails are thrown up over the slip switch and outside of the ties. The half of the slip switch is then lined into place and gaged at each joint and each switch and frog point. The gage is laid across from the old track rail which has not been removed. If the plates for the switch point rails have not been placed, they must be applied, when gaging. After spiking the

joints and points, the track can be made safe for slow traffic by spiking one tie near the middle of each rail (b) and (c′). The construction of a slip switch is such that it is practically impossible for any of the rails to tip over and the weight is almost great enough to keep the rails from spreading under a train running over the straight route at reduced speed.

The remaining side of the switch is put in, in a similar manner, whenever time is available. A foreman must watch the laborers carefully to see that they make no mistakes such as removing and exchanging tie plates, or placing the gage on the wrong rail, where two rails are close together. Before spiking up the second side of the switch, all joints and plates should be put in, as well as all joint, heel of switch and frog castings, and straps called for on the plan. It may be necessary to drive some of the rails a little to get the straps, etc., connected up.

Setting Up Slip Switch Complete Outside of Track— If there is plenty of room, the method of setting up the entire switch outside of the track and then lining it in all at once, is an excellent one. Or the switch may be entirely constructed, where space is available, loaded and moved to the location on a flat car, the ballast stripped out, the old switch lifted out bodily and the new one lifted in by a steam derrick or locomotive crane. It is especially advisable for an inexperienced foreman to set up the switch complete, outside of the track, as this will preclude the possibility of getting the rails and fastenings mixed while the track is torn up, and delaying traffic while getting things straightened around. Connection rails (k) and (k′), (j) and (j′), may be cut and bolted up with the switch.

The method of putting in one side of a slip switch at a time causes little interruption to traffic. It is a very satisfactory method because if the old track is in good line and the gaging is properly done, the completed switch will require practically no lining up. This is a big advantage because the great weight and the interconnections between the rails of a slip switch make it difficult to line.

Spiking—After the slip-switch rails are all in place, a small gang of expert and intelligent spikers should be kept on the work and a few men should be started to putting on the switch rods. Spiking requires the careful attention of the foreman, and if a large number of spikers are kept at work it may be impossible to prevent poor gaging, spiking tie plates on the wrong ties, and other incorrect work.

Several Slip Switches in the Same Track—It frequently happens that several switches for an interlocking plant are to be put in one track quite close together. In this case a saving of time and also of cut rails can frequently be effected by setting up two or three switches in two parts on opposite sides of the track, with connecting rails between, and throwing in one side of the whole layout in one operation. Quite a large force of men is required to do the work when using this method.

Inspecting Similar Layouts—Valuable hints may be obtained by an inspection of switches which are similar to the one being constructed; but as standards change, it is quite likely that a new switch will be somewhat different from the old one. Switches under construction should be kept in correct surface and alinement, or else properly protected by slow flags and lights.

Locating Crossover Frogs—In laying either ordinary or slip-switch crossovers, the distance between frog stakes should be checked before starting work; and if found correct, each switch may be laid independently. If the distance is incorrect, as can be determined by reference to the table in the Appendix, the location for one frog should be changed and the distance between them corrected.

When there is any uncertainty, the exact location for the second frog may be found by laying one or more rails behind the first frog and lining these accurately with the frog tangent. Then by using a track gage the point of frog may be located as follows:

Place the gage on the rail behind the frog and move it along until the opposite side of the gage just touches the gage line of the nearest rail of the other track.

Checking Material—In laying a single- or double-slip switch, especially in main line, the material should be very carefully checked up beforehand by the foreman, so that he is sure before the track is cut that lack of material will not cause a delay. This precaution will prevent interruption of traffic.

CHAPTER VIII.

SURFACING NEW TRACK.

Preparation of Subgrade on New Track—When trains run over a track on a level-topped grade before it is ballasted, the ties sink into the dirt several inches, the depth depending on the compactness of the soil, amount of moisture, etc. A longitudinal section would then look something like Fig. 43. Dirt should be leveled off to the bottom of the ties before ballast is applied to such a roadbed. One of two

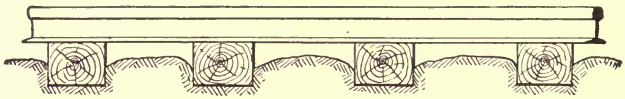


Fig. 43. Longitudinal Section of Track on New Grade After Being Used by Construction Trains.

methods may be followed: The whole grade can be cut down to the bottom of the tie and the dirt thrown over the shoulder, or the track can be raised and the dirt between the ties tamped under them. The latter method is usually followed, and leaves the top of the roadbed somewhat like the cross section in Fig. 44.

After the track has been ballasted the center part of the subgrade will continue to settle, so that even if the top is made level before ballasting, the subgrade will gradually assume a trough or dish-like shape. The depth of this trough may easily be from 8 to 15 in. on a subgrade of fairly good material. It is this condition which is often to blame for the fre-

quent raising of track out of face and the application of more ballast, when in reality what the track needs is merely drainage. In the recent valuation of railroads many places have been found where the ballast was 4 ft. or more thick, where the track still was settling and where orders were constantly being made for more ballast with which to raise the track.

Since gravel and crushed stone are pervious, rain water soon penetrates to the subgrade and if it is dished, or even if the original depressions made by

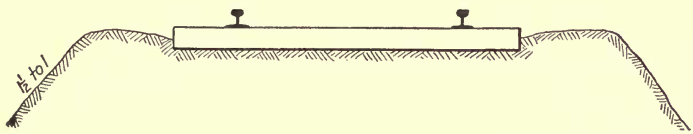


Fig. 44. Transverse Section of Track on New Grade After Being Used by Construction Trains.

the ties in the subgrade are left, the water will accumulate and the subgrade will become continually softer. The softening of the grade allows the ballast in the track to settle further and further and the condition becomes continually worse. The water which collects in this manner must soak through the side of the subgrade before it is rid of. If the surface of the subgrade were higher in the middle than on the shoulders, or even if it were level, the water which penetrates the ballast would find a natural outlet along the top.

It is a good idea to dig down the shoulders of the subgrade 10 or 12 in., just before ballasting, provided the top of the subgrade is dished, thus making a cross section similar to Fig. 45. The dirt obtained in this manner may be used for widening the banks

where they are narrow, or can be thrown in between the ties, and the track raised sufficiently to take this dirt, which may merely be tamped with shovel handles. After this is done and traffic is turned on the track for a few days, the subgrade will be in excellent shape for the application of ballast. The final approximate appearance of a cross section after the application of ballast would then be like Fig. 46.

Every precaution should be taken to make the subgrade solid and compact when it is built. Since much construction work is rushed through hurriedly, how-

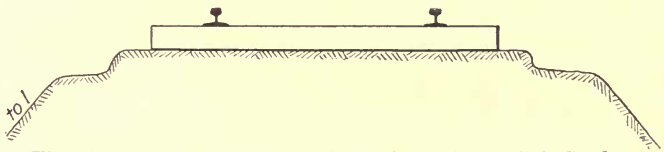


Fig. 45. Suggested Method of Finishing Top of Sub-Grade.

ever, this is not always possible. Where the dirt is dumped off of high trestles it is almost impossible to get the subgrade in good condition for ballast, while in other places the subgrade may be built in the winter and large chunks of frost used.

The dishing of the grade and its effect have been well recognized by the Baltimore & Ohio railroad, which now requires, as one of its standards, a drain in all double-track, consisting of a line of tile laid in the center of the grade between tracks, with outlets to the ties.

Frequent Surfacing Necessary—Uneven surface will quickly develop in new track. And while most track men are familiar with surfacing track on an old bed, there are some differences in surfacing on a new bed which should be mentioned.

Type of Ballast Cars—No matter what type of ballast cars is being used, the foreman should carefully examine the ballast, in case there is likely to be any which is unfit for use; and cars of poor ballast should be switched out before the train starts to unload. Ballast cars may be roughly divided into three classes —center dump, side dump and plow cars. Cars used for plowing are also frequently called side dump.

Wherever the dirt or ballast is stripped out from

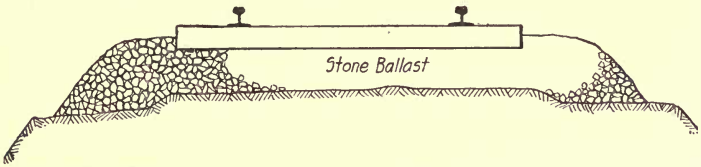


Fig. 46. Final Approximate Appearance of a Grade Finished as Shown in Fig. 45.

between the ties, center dump cars will be found to be the more efficient. They drop the ballast in such manner that it can be spread and then put under the track with practically no rehandling. Where the track is not to be stripped out (and this does not happen very often unless a very light raise is being given) it may be impossible in some cases to drop enough ballast in the center of the track to give the desired amount for the raise. In most cases, however, where the raise is high, the dirt or ballast will have been stripped out; and in cases where the raise is low, usually the center dump cars will give enough of a spread anyway. With other methods of unloading, more equipment and the rehandling of the ballast are necessary. An engine, plow and cable are used extensively in ballast work. With this method, as with center dumps, the train can

be moved along as it is being unloaded, thus preventing the ballast from piling up and burying the wheels of the train.

The air side dump cars or Lidgerwood and side plow are especially adaptable to making a high fill where the track may be constantly lined over to the edge of the fill, as the work progresses. Air dump cars, however, cannot be used as standard equipment for winter service, and so they are not used very extensively in ballasting work. The Hart Convertible car can be used either for center dump or for plowing, and is convertible into a standard gondola car, for use in the winter. A great many trackmen favor cars of this type.

Sags—Where there are sags of 6 in. or more in the track which is to be ballasted, these should be taken out before the general distribution of ballast. This will make it possible for the surfacing gang to bring the track uniformly up to the stakes. Raising the sags first also makes it unnecessary to haul ballast through the surfacing gang and distribute it back of them, assuming that the surfacing is progressing toward the gravel pit.

Unloading Ballast—If the ballast is being unloaded from center dump cars, the car at the head end of the train should be opened first and the following ones opened in rotation as required; then the empty cars will not have to run over the track where ballast has been unloaded.

An experienced gang of men should be used on the unloading. Inexperienced men are likely to dump too much in a place and to stall the train or derail the

cars. A spreader or track plow should be used at the rear of the train to plow the ballast out over the shoulder, and should throw out enough gravel from the flangeway to prevent stones from being struck by trains. The train should be kept in motion while the gravel is being unloaded, and not more than two or three cars should be opened at one time. The second car may be opened gradually as the ballast is dumped from the first, the third after the second, etc. By handling this work carefully an even distribution can be obtained.

If no track plow or spreader is available the gravel may be plowed off by using ties in front of the car, piled so that there will be a practically perpendicular face, enough being used behind the front row to solidly brace against the wheels of the car. When plowing off in this manner the wheels of the car will slide and become flat, unless shoes are provided. Shoes for this purpose are made of iron straps about 3 in. by ½ in. in section, bent in a curved form at the bottom to fit the wheels, with a straight vertical leg ending in a hoop which fits over the top tie. The front pair of wheels is pushed up onto these shoes, the shoes sliding on the rail, and thus protecting the wheels. This method of spreading ballast is not to be recommended. Not only does it fail to throw the ballast far enough out, but it does not flange out the track, and it packs the ballast down solidly, so that when raising, the ties are likely to drop off on account of the pressure. Roger Ballast or Hart Convertible cars, used for center dump, have been unloaded for 6 cents per car, for the time actually used in unloading.

SURFACING.

Organization—In the organization of a surfacing gang the work should be arranged so that: (1) Laborers will not have to double back, and thus cover an extra amount of territory. (2) Men will not have to pass, but will always follow each other in the same order. In this way time will be saved, while in the tamping good work will be mixed with poor, resulting in a more uniform job throughout. When laborers have to pass each other, as they would, for instance, if each gang of tampers tamped a complete rail length, there may be a lot of time wasted "visiting" as the laborers from the back pass the others in proceeding to the front.

With 67 men, the following organization will be found efficient:

1 spot board man.
2 jack hole diggers.
6 jack men.
4 jack tampers.
4 men filling in for jack tampers.
1 hammer man.
1 levelboard man.
8 men filling in.
16 men tamping ends.
8 men filling centers.
16 men tamping centers.

Total 67

General foreman, 1; assistant foremen, 2; Track Raiser, 1.

Spotboard Man—The spotboard man sets up the spotboard on the stakes and levels it; or in case there are no stakes, he sets it from sights made by the foreman with his blocks. Two spotboards should always be provided, so that the spotboard man may be setting up one while the foreman is sighting to the one

in the rear. A spotboard bracket (page 35) should be used; it consists of a steel slot with a point, which is driven into the ground; the spotboard rests in the slot at the top, and is thus prevented from blowing over or falling off the stakes.

Jack Hole Diggers—Jack holes should be dug about two ties ahead of the joints and about the same distance ahead of the centers of the rails. Jack holes should always be made level on the bottom and plenty large enough for the jack blocks. If the hole is made rounding toward the ends, all the strain will come on the ends of the jack board, breaking or bending it.

Jack Men—Three men should handle each jack, two of them carrying the jack forward, the third carrying the jack block. An ordinary joint plate makes an excellent jack block, if provided with a handle by twisting wire around through the spike slot holes. Extra jack boards should be provided, so that the man who handles them may move on ahead of the gang and set the plates in advance, while the joint in the rear is being raised.

Jack Tampers—Two jack tampers should be assigned to each jack, so that it will not be necessary for the jack men to drop the handle and do the tamping. The jack tampers should start working just as soon as the men start to raise, so that by the time the raiser gives the word, "High," the tie will be tamped sufficiently so that the jacks may be dropped immediately. It requires both skill and practice for the track raiser to become so expert that he will not raise the joints too high or too low. Once this method is mastered, however, vastly greater progress can be made.

Men Filling for Jacks—Two men should be assigned to each jack, to fill-in ballast for the tampers. The best men, and plenty of men, should be used around the jacks. With a gang organized in this manner, two jacks will raise as much track as a gang of 67 men can finish, when the raise is not more than 6 in.

Levelboard Men—The level man should stay with the jacks and see that both sides are brought up together. If one side of the track is brought up first and tamped, the first side will be raised too high when the other side is leveled, because the tie will rest on the ballast at its outer end and tip up; also this will leave a space under the tie where there is no ballast. The levelboard man should set the spotboard block for the foreman. Or the level may be trimmed down to the correct height on one side and used instead of a spotboard block.

Hammer Man—The hammer man should carry a wooden sledge and not a spike maul. The track should never be lifted so high that more than one or two blows will be required to bring it down to the spot. The hammer man should carry an extra spotboard block, so that the joint may be sighted and knocked down while the jacks are being moved ahead.

Men Filling Ends—Eight men, four on a side, should fill-in for the tampers. This work should be carefully supervised, as a tie tamped with insufficient ballast represents wasted work.

Organization of Tampers—The tampers should be organized to tamp the track in the following manner: If there are four pairs of tampers on the ends, each side, the head pair should tamp every fourth tie, the next pair the tie behind that, the third gang the next

to the last tie, and the last gang the last tie. The center tampers should follow a similar system. Besides keeping the men working close together, without interfering with each other, this method makes it possible to get more work out of men who would otherwise "soldier." And, more important still, the track as a whole is tamped in a more uniform manner. Under the old method, where each pair of tampers was assigned a rail or half-rail length, the sections tamped by the best tampers stood up better than the rest, and consequently the track settled unevenly and became rough. Where the good tamping is mixed with the poor, the whole track is more likely to settle uniformly.

Center Filling and Tamping—The centers should be tamped about 16 in. inside the rail on low lifts and all the way across on high lifts. The men filling-in should not be allowed to rob some places of gravel and leave a surplus in others.

Tamping Tools—When the lift is more than 1½ in. it is better to allow for settlement and tamp with shovels instead of tamping bars (except in stone ballast). When the raise is small and the bed is hard, the tamping bar is the most efficient tool; but it is seldom that tamping with bars is profitable in surfacing new track, as the subgrade settles so much that the track will get out of surface, no matter how well the tamping has been done.

Recently tamping machines, which operate by air, have been put on the market and used successfully. There is no question but that they are of exceptional value around interlocking plants, or at other points where it is hard to do tamping with picks.

The Track Raiser—An active man with a good eye

makes the best track raiser. He should be careful to sight from about the same distance back of his jack each time, and should raise joints and centers with the spot, thus making it unnecessary for the laborers to double back and raise the centers. In other words, he should raise the joint, then the center ahead to the spot, then the joint ahead, etc.

Foreman and Assistant Foremen—One of the assistant foremen should raise the track and the other should look after the tamping. The foreman should keep a general supervision over the whole work, look after the flagmen, watch the time cards, and see that no part of the work is holding up the gang. If the jacks are inclined to lag, more or better men should be put around them; if the end tampers are holding back the center tampers, the force should be rearranged. The track foreman should constantly be studying out new ways of arranging the men or the work, to lessen the amount of labor necessary in raising a given amount of track. Many foremen hang to the methods which they learned when they were first employed on track, and consequently do not get out as good or as much work as a man who is up-to-date.

Tamping Centers—Track centers must be tamped when making a high lift, and this is especially true of mud or dirt-ballasted tracks. When making a low raise on an old track the centers should be tamped for about 16 in. inside each rail, but not directly in the center of the track, as that is likely to cause center binding. When tamping centers all the way across, the heaviest tamping should be next to and under the rail, but the ballast should be tamped under the center sufficiently to completely fill the space and not leave

pockets which may be filled by the first rain. On a bridge approach the track should be raised higher than the bridge. The fill settles and the embankment tends to spread, while the bridge stays up. Such places should be inspected and raised again after each rain, if necessary.

Lining Track—The foreman, in lining track, should stand with his back to the sun, if possible. For lining out long swings he should stand as far away from the gang as possible, giving his orders entirely by motions. In this way he can line the joints and centers to an approximate line, or if necessary, he can take every fourth or fifth joint and throw this to correct line, and then go back and line the rest of the track to these correct points. In lining out short kinks, where the general line is correct, the foreman should get much closer to the gang, so that he can see the small imperfections.

In lining up-grade the foreman should sight the track from both directions, as this is a point where the line frequently is not good, because the track beyond the summit cannot be seen. The foreman will save a good deal of time by looking at such a piece of track from both directions before he starts work on it. Particular pains are required in lining the points of curves and the adjacent tangent track. The foreman should look at such places from a distance of a quarter of a mile, to be sure that he get the track in correct line.

The policy of leaving long swings in the track, rather than to take the time and trouble to line them out, is to be strictly condemned. The writer knew of an instance where a swing of 6 in. was taken out of a piece of track, it requiring about three-fourths of a day of a

large extra gang's time. This track had been gone over by two extra gangs before that time, both gangs having left the swing in the track rather than spend the time to correct it. The foreman who finally took it out got a black mark for spending so much time at lining.

The proper length of string to use for lining curves is 62 ft. The deflection at the middle of such a string will be 1 in. for each degree of curve. For instance, on a 6 deg. curve, the rail should be lined within 6 in. of the string at its center. The cord can then be moved ahead a half length, or 31 ft., and another point lined out 6 in. from the center of the string, and so on, all the way around the curve. The parts of the track between these points should then be lined by eye. Many railways are now spiralling or easing their curves. (This may also be done by the use of a string. See Rench's book, "Simplified Curve and Switch Work.")

Height of Raise—A raise up to 9 in. may be made in one lift. If more than a 6 in. raise is being made, however, two "swing jacks" should be used in advance of the raising jacks, to spring the track up enough so that the rails will not be surface bent. No tamping is necessary with the forward jacks, as the ballast will run in sufficiently to hold the track up. Where a 12 in. raise is being made there should be two lifts. After making the first lift in stone ballast, the stone should simply be bladed-in clear across the tie and not bar tamped. On the second lift the bars or tamping picks should be used and the centers tamped 16 in. inside the rail. When a raise of 9 in. or over is being made, the track should not be shouldered up until the

smoothing gang has gone over the work and picked up the low spots which have developed.

General Notes—When starting a new gang the foreman should be careful to see that the tamping is done right. New men are likely to tamp against the side and not under the tie, particularly if the raise is 2 in. or less. It is difficult for some men to grasp the idea of how to shovel-tamp a tie, and the foreman will have to exercise a good deal of patience in teaching them. It is best to teach by example, the foreman or assistant foreman taking hold of the shovel and making the motions slowly, so that the green man may gradually learn how it is done.

When filling-in for the tampers, the assistant foreman or foreman should not allow gravel to be taken from a spot where it is short, nor should he allow the men to dig borrow pits. If this work is watched closely and the ballast cast from places where there is too much, to places where there is not enough, there will be little redistribution to make behind the surfacing gang.

The track should be lined daily, before filling centers. If the track is not too tight, it should be lined at night and centers filled in as close up to the front as possible, in order to be prepared for rain. If the track is tight it may be impossible to line the kinks out of it until the following morning, when the rails have contracted.

The track should be dressed, finally, to the standards of the road. A template is a very handy appliance for use in shouldering. It consists of a long plank, similar to the spotboard, which is laid across the track, having depending boards placed at the proper points to indi-

cate the edge of the shoulder, its top and slope. A ballast spreader can also be used for shouldering.

It is difficult for most section foremen to take hold of a new section and handle the raising in a satisfactory manner. New track goes out of line and surface in so many places that one is at a loss to know where to begin. If it is desired only to smooth up new track, the foreman should carry the level personally, and it might be well to say here that if track is level, even if it is rough, it will ride fairly well—much better than track which is somewhat smoother and not level.

It often occurs that each individual rail is in fair surface, and yet the track is out of level, the rail running lower first on one side and then on the other. Such a condition causes the weight of the trains to be thrown unequally on the rails, thus tending to increase the settlement on the low side. By always using the level board this defect will be gradually corrected. Some foremen make the mistake of thinking they can tell when track is level, by the eye. We have heard many trackmen boast that they can do this, but have never seen any one prove it in a test.

New track should be raised high, especially if it is down and the mud shows occasionally between the ties. Even the second lift on new track should, in general, be 2 or 3 inches, and a 6 in. lift will frequently prove most profitable. However, the track must not be raised so high that there will not be enough ballast around the ties to prevent sun kinks. With heavy, coarse gravel there is not as much danger of sun kinks as with fine gravel. Good judgment must be used in putting the track up only so high that the ballast dressed in will be sufficient to hold it in line of surface.

Testing for Level—A foreman can test straight track for level as follows: Find a spot where the track is level, place the level board on the hand car and block it to read level. Then push the car along slowly and notice how the bubble varies and where the low rail changes from side to side.

Records—Records made in surfacing track are a fine endorsement for a foreman, provided the work stays up, or provided he gets far enough away before it goes down so that he cannot be held responsible. But low lifts and omitted tamping on a new track simply represent company money thrown away, although the individuals concerned sometimes succeed in attaining their own advancement. This condition would not exist if less emphasis were laid on the number of feet of track laid per day and more attention paid to the quality of the work. As it is now, in many cases, those in charge of the track foremen look only at the amounts of track raised and so they encourage poor work.

***Cost of Surfacing Track**—The following costs were obtained with a gang organized somewhat as follows, varying the number of men filling-in and tamping track as conditions required:

1 spot board man,
2 jack hole diggers,
6 jack men,
4 jack tampers,
4 men filling in for jack tampers,
1 level-board man,
1 hammer man,
8 men filling ends,
16 men tamping ends,
8 men filling centers,
12 men tamping centers.

The costs have been shown under two divisions. In the first portion the rate paid laborers was $2.00 per day, the work being done in the cool, early spring

*From an article contributed by the author and Charles L. Van Auken, to *Engineering and Contracting*.

months, from April 17, to May 28, 1913. The costs in the second part represent totals where the ordinary rate for laborers was $2.25 per day, work being done in the summer months from June 7 to October 3, 1913.

The total cost chargeable to track raising during the early period was $5,064.00 for raising 60,100 ft. of track, an average raise of 6 in. This figures out about $445.00 per mile, including lining and dressing up the track to standard.

The total costs chargeable to track raising during the period with laborers at $2.25 per day was $7,850.00 for 74,400 ft. with an average raise of 6 in., which figures out $560.00 per mile. These figures also include dressing track to standard.

In both cases the ballast was clean gravel, but too fine to make the most rapid progress. It was, however, quite easily and quickly tamped. The track was shovel-tamped only, clear across the ties, as the softness of the grade precluded the possibility of center-bound track.

Especial emphasis should be given these costs as they give comparison between:

(1) Costs of doing work with $2.00 labor and $2.25 labor.

(2) Unit costs in the early spring and unit costs in the hot summer months.

(3) The effect on costs of breaking up and reorganizing a gang.

The first gang struck for a raise of wages which was refused, and new men had to be procured at an increase of 25c per day and a very poor class of laborers was obtained, due to the summer demand. The gang hired in the early spring was American labor, while many foreigners were included in the second gang. The figures

show that work in spring months can be done much cheaper, due to the cooler weather and the fact that better laborers can be obtained at lower wages.

The cost of breaking-in or organizing a new gang is not generally appreciated by many railway men. The costs were so much greater in this case that the contractor would have been justified in raising the wages of the old gang to at least $3.00 per day. The work done in the spring was 20% cheaper than that done in the summer.

Two reasons are given for the low unit cost of this work—ample supervision and quality labor. Few railroads would allow three assistants and one general foreman at a total of $15.50 per day to supervise a gang averaging about 70 men. The railroad gang of this size is usually supervised by one foreman and one assistant, totaling about $6.50 per day. And notwithstanding this poor supervision the railroads pay less for their laborers and get men who are in much greater need of supervision. The work described herein was done by a contractor.

The same foreman handled both gangs and the costs in each case include the extra cost of organizing, as each gang was made up from new shipments of men. The writer's experience would indicate that $445.00 per mile for giving a 6-in. raise and dressing up track, is one that it is impossible for many railway company gangs to even approach, at the prevailing wages of $1.50 to $1.75 per day.

The conclusions to be deduced from the above is that it is highly profitable to:

(1) Allow ample supervision—say one assistant foreman to each 25 men.

(2) Hire men as early as possible in the spring.

(3) Pay quality prices and obtain quality labor.

(4) Push the work vigorously in the cool months.

(5) Use every possible means to retain an experienced and organized gang—it will pay well.

(6) Raise the wages of old men rather than hire inexperienced, incompetent men.

CHAPTER IX.

YARD CONSTRUCTION.

The design and layout of terminal freight yards vary considerably with the location, size, available space and purpose; and few laws can be said to govern all cases. In the matter of construction, however, there are many points that are invariably essential, no matter what the design or location.

Grading—In the majority of cases, large terminal freight yards are constructed upon low, level ground where little or no excavation will be required and grading therefore consists mainly of filling. For this reason the work of grading is similar to that for track elevation and the necessary fill is usually hauled to the site by work trains from nearby sand or gravel pits. It is quite essential that terminal freight yards, where a large amount of switching is done, should be easily drained of surface water, and drainage is made much more simple and certain when yard tracks are constructed upon a fill.

If the fill is low and the ground firm enough to support trains without serious damage to track or equipment, the tracks may be laid approximately in the final position, and the filling distributed from each track, after which each track is raised as high as possible with the distributed filling material and thus made ready for additional trains. This method is repeated until the tracks are up to the desired grade. Earthwork in large quantities is handled most advantageously by machinery, the cars being loaded at the pit by steam shovels and un-

loaded by center or side plows operated by a Lidgerwood. Side-door gondola cars with sheet metal aprons between are convenient with this method. The unloading plow is pulled through the train from the rear to the car immediately behind the Lidgerwood. If a "heavy spread" is desired, cars are plowed with the train standing, while a "light spread" is obtained by plowing with the train moving, the desired amount of material being unloaded by varying the speed of the train while plowing. When plowing "heavy" the foreman must see that the rail is kept clear of large stones and boulders, and that it is not buried so deep as to cause derailment and delay when the empty train is pulled out. When the train is unloaded it is pulled to a siding, where the Lidgerwood and car containing the plow are cut off. The Lidgerwood is then switched to the front of a train of "loads" and the car with the plow to the rear of this train. Upon a parallel track (13-ft. centers) a box car, fitted with a cantilever arm, is brought alongside the Lidgerwood. The cable which pulls the plow is attached to the cantilever arm on the box car and by pushing the box car to the rear of the train, the cable is unrolled from the Lidgerwood drum and stretched over the train of loads on the adjacent track to connect with the plow on the rear car.

When unloading on a curved track the cable pulling the plow must be secured at suitable intervals to assure the pull being approximately tangent to the body of gondola cars, so that the plow will not tend to cut through the side of a car.

With a high fill and in hump and gravity yards, it is usually found more desirable to build one or more tem-

porary tracks from which to construct the fill for the entire yard.

The method above described is used to get the temporary track to its approximate grade and then from this the fill is widened out by unloading with a side plow and spreading with a "Bulldozer" or mechanical spreader. When fill has thus been constructed alongside as far out as the spreader wings will reach, the track is thrown or lined over with lining bars to the edge of the newly made bank and the process repeated, this finally completing the grading for the entire width of the yard.

Staking Out Tracks—In laying out ladder tracks either the engineer's instruments or an ordinary tape line may be used. In tables 4 and 13, at the back of the book, are given information which can be used by any track man to lay out a switch of any angle from No. 6 to No. 14. The proper procedure is to start at the point of frog leading off from the main track to the lead and mark points at every 100 ft. along the main track from which the lead turns off. Then, starting back at the first 100-ft. point, a distance of 12 ft. 6⅝ in. (as shown in column 2, table 13) should be laid off at right angles to the rail and a stake driven at this point. At the 200-ft. point a stake should be set 25 ft. 1⅛ in., as shown in column 3; at the 300-ft. point the stake should be set 37 ft. 7¾ in., as shown in column 4; at the next station the stake should be set 50 ft. 2⅜ in., as shown in column 5, and at the 500-ft. station a stake should be set 62 ft. and 9 in. from the old track. Table 4 shows the distances between ladder frog points measured along the ladder, for different track centers. Assuming for the No. 8 frog that the tracks are to be 13 ft. apart, in column 4 of table 4, it will be found that the frogs should then be located

104 ft. 5 in. apart all along the ladder. The frog points can then be laid out 104 ft. 5 in. apart along the line established by the stakes originally set.

Distribution of Material—The distribution of material is a matter which requires much skill and experience. If the material is properly distributed the work can be done speedily, while if the material is not properly distributed general confusion will result, causing delay and added expense.

On large construction jobs, material yards are built. All material is shipped to this yard, and it is checked up before being distributed. From this point material is sorted, loaded, and carried by train as near to the place where it is to be used as possible. Track material for the leads or ladder tracks is placed near the point where the lead runs into the main track, or previously existing track. Sometimes a temporary track is laid on the site of the proposed lead, and all material for the leads is distributed from this track. When no temporary track is laid, the material for each switch is carried forward on push cars running on the ladder track which has just been laid. Material for the tracks between the leads is distributed either from the temporary track, or by bringing up material from the rear by push cars running on the newly-laid track, and then carrying it ahead by hand. When one track is laid clear through the entire yard, material for the two adjacent tracks is distributed from trains running on this track, and this method is repeated then with the next track, and so on across the entire yard until all of the track material is on the ground in the proper place.

If material is not properly distributed there will be a tendency on the parts of the individual foremen to supply

their needs from the nearest source, without regard to whether such material is needed at the place it was taken from. When this practice is resorted to, general confusion and delay result immediately. It is far more economical to provide proper and early distribution of material. In ordinary practice, even with skillful men, material cannot be perfectly distributed for all parts of the work on any piece of construction of considerable size. It is therefore customary and good practice to keep a material gang constantly on the work. When not employed with material this gang may be used to help out in other lines of work. This gang should promptly take care of material that has been used in temporary work. If this is not done, in large cities there is a possibility that the material may be stolen. This is especially true of timber.

The work of handling material properly is seen to be of primary importance, for without material the work of construction cannot be commenced and even when once commenced it is at all times dependent upon material for its continuance and completion.

Laying Switches—As soon as the track material is on the ground the laying of the switches is commenced. For this work a gang of about twenty men with foreman and one assistant, or a gang of about forty men with a foreman and two assistants will be found economical. This assumes that the laborers employed are foreigners or a class of men not familiar with the work. Under these circumstances larger gangs cannot be conveniently handled for the foreman must not only watch each and every part of the work, but he must also, from time to time, demonstrate the method of using tools.

Laying Yard Tracks—The yard tracks between the

two ladders are usually straight and their construction is much more simple than the construction of the switches. Sometimes second-hand or used material only is furnished and often rails of varying lengths and different weights are used. This fact introduces many little difficulties which do not arise in main-line construction where new material is used; but as yard tracks are never used for high speeds the niceties of construction may be overlooked. Here, as in many phases of railroad work the object is not to produce a perfect piece of work, but to make it amply adequate for the purpose in view in the quickest possible time, and with the least expenditure.

The best way to lay the tracks in a large yard is to first lay the track at the center of the yard, using the iron car. The material for the two adjacent tracks may then be unloaded from this track, the material train being followed by one or two track gangs, putting down the adjacent track or tracks. If the work is organized right and this method followed, it will run along systematically and there will always be at least one track, and generally two, from which the material trains can work.

Sometimes it is desired to run the construction of the yard faster than the method mentioned in the last chapter would allow. In that case, it is customary to lay every second or third track throughout the yard, possibly laying them on the ground and raising them to the correct elevation by unloading, filling and making successive lifts of the track. The fill for the grade of the adjacent track may be made with a spreader, and the material for adjacent tracks may be distributed from the track from which the filling was made. Building a yard in this manner makes it possible to use a much larger force of men because there will be many tracks from which filling can be unloaded at

one time, as well as much grade ready for track construction and afterward lots of room for the surfacing gangs putting in the ballast.

It is sometimes desired to get some filling into the yard before the ladder track is finished, in which case it is customary to lay a temporary track outside of the ladder and turn it down into track near the center of the yard, from which work may be started.

Then, when the ladder is built up to this point this track can be connected in behind one of the frogs and become one of the permanent tracks. Whenever laying temporary tracks on a yard site, information should be obtained, if stakes have not already been set, as to just where the tracks should center. Then, when laying the temporary track it may be placed on the center line of one of the permanent tracks and thus save rebuilding it, or building a new track.

Surfacing—The surfacing gang follows the track-laying crew. The surfacing material, usually sand, gravel or cinders, is unloaded from cars by hand, by the method described for earthwork, or by patent dump cars, and then spread by means of plows. A method of spreading material sometimes used where no mechanical spreader is provided, is to run the rear wheels of the rear truck of the train upon iron shoes which slide upon the rail and hook over a tie placed upon the rails directly in front of the wheels. This arrangement forms a flat-faced plow which spreads the material even with the top of the rail, and prevents the material from getting under the wheels and derailing the gravel train.

After the track has been surfaced, it is dressed up according to the standard required by the engineer in charge and then is complete and ready for use.

A top layer of cinders of shallow depth over the entire yard has been found desirable to supply a firm walking surface free from mud. When thoroughly packed a layer of cinders will readily allow water to pass through and will also present a good walking surface shortly after a severe rain storm, where proper drainage is supplied.

Sewers and Drains—The necessity for providing adequate drainage for terminal and switching yards cannot be over-emphasized. Failure to supply an ample and properly planned and constructed drainage system may make an entire portion of a yard useless in wet seasons. Not only will tracks settle so as to be out of service, but in some cases portions of the yard will be impassable on foot.

When putting in the drainage system after the fill has been made and the track laid in the yards, there will be a good deal of difficulty in holding up the ballast, which is usually loose and ready to run, and in getting the trenches dug beneath the track. When doing this work the ditch should be kept carefully sheeted up all the time, otherwise cave-ins are likely to develop, especially if it rains. A few cave-ins will double the cost of the work.

The course of the drains having been decided, the engineers stake out the center lines and place grade stakes (usually called "cut stakes") at convenient intervals. On each stake is marked the depth of the bottom of the trench below the top of the stake. The width of the top of the ditch depends upon the depth, the width desired at the bottom, and the material in which the excavation is being made. Lines are stretched along the surface of the ground to mark the limits within which to excavate. Usually, conditions do not warrant

the use of trenching machines, and the excavation is done by hand labor.

A long, straight edge, with a track level on top of it, placed on top of a grade stake and leveled with one end held against a graduated rod placed in the trench, will give the depth of the bottom at the point where the rod is held. As soon as a few feet of the trench are completed, the pipe-laying is commenced. It is well to keep the pipe laid right up to the completed excavation, so that in case of "cave-in" or excessive storms, little excavation will have to be done over. When the grade is slight the pipe should be laid level between stakes, except for the last few lengths, and the entire grade for the distance put in the last few lengths. This will prevent running below grade at any point, and with the class of labor usually secured by railroads, this is a necessary precaution.

For building manholes and catch basins, a brick mason should be employed. If for any reason water has a tendency to collect and stand in any part of the yard, additions to the drainage system should be made to remove the water.

When a yard is located in a low spot, the surface water from surrounding land has a tendency to flow toward or into the yard, and it is well to dig "berm" ditches parallel to and alongside the yard and thus detour the surface water. Standing surface water or marshes adjacent to the yard should be drained by ditches where practicable.

Repairs During Construction—Frequently, when a portion of a yard has been completed, it is either turned over for use by the operating department, by construction trains, or is used for storage purposes. In any case, in a

new yard there are frequent derailments caused by running through switches, etc. Considerable repair work is necessary and in the case of a large yard, one entire track gang may be occupied in no work other than repairs. This affords an opportunity to study the faults of construction gangs and devise means of correcting them. Thus in cases where nothing better than lightweight rail and cedar ties are furnished for curves behind frogs, it will often be found necessary to replace soft ties with oak ties, due to rail turning over under heavy engines. Heavy rail is often substituted or provided in the first place for curves, and if used on oak ties and well braced with rail braces, properly lined and superelevated the curves should give no trouble. In extreme cases it may be found expedient to provide bridle rods or guard rails.

It is not unusual to find that much sniping (raising low joints or low spots in track) is necessary in a new yard, either on account of the fill settling unevenly, becoming soft on account of poor drainage, or failure to secure proper tamping when surfacing. When portions of a new yard are just beginning to be used extensively, much sniping will be found necessary to keep the tracks in good shape, otherwise the surface of tracks soon becomes so poor that derailments are frequent. Odd jobs, such as correcting poor gage, adjusting bridle rods and the throw of switches to make points fit, keeping switches clear of gravel and drilling rails, etc., will keep one foreman and quite a number of men busy, and take time and money, neither of which is included in the estimate in many cases. In fact, it is seldom that the item of repairs during construction is considered from any standpoint until it thrusts itself on the schedule and compels immediate attention.

APPENDIX.

Most foremen are familiar with the method of laying out a curve with a 100 ft. line and a rule. As few foremen have 100 ft. tape lines it is thought that this method applied to a 50 ft. tape would be handier and more applicable to their use in general. The illustration, Fig. 47, shows the way this method is used. The tape

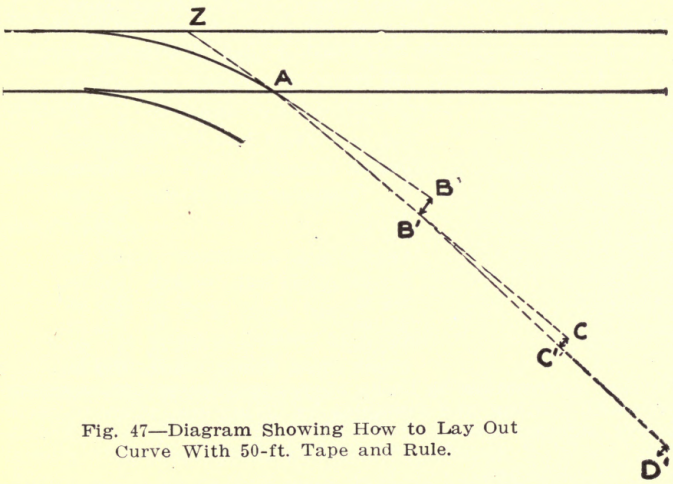


Fig. 47—Diagram Showing How to Lay Out Curve With 50-ft. Tape and Rule.

line is stretched and lined up with the turnout side of the frog, the point Z being the zero end of the tape, the point A or frog point being at the 25 ft. point, and B being the 50 ft. point. From Z to B is a straight line. A distance is laid off from B to B′, which is shown in the table as "Offset from tangent for 25 ft. chord." The tape is then moved forward and the zero point placed at A and stretched tight with its center over B′, its ex-

treme end extending to C. From C to C′ a distance is measured off as shown in the third column of the table called "Offset from Curve for 25 ft. chord."

The table is very simple, the first column giving the degree of curve from which the foreman can pick out any degree which he wishes, from 1 up to 14. If it is a 7 deg. curve, his first offset will be 4½ inches and his succeeding offsets in each case will be 9⅛ inches.

Table for Laying Out Curves.

Deg. of Curve	Offset from Tangent for 25 ft. Chord.	Offset from Curve for 25 ft. Chord.
1	⅝ in.	1¼ in.
2	1¼ in.	2⅝ in.
3	2 in.	4 in.
4	2⅝ in.	5¼ in.
5	3⅜ in.	6½ in.
6	4 in.	
7	4½ in.	9⅛ in.
8	5¼ in.	10½ in.
9	5⅞ in.	11¼ in.
10	6½ in.	1 ft. 1⅛ in.
11	7¼ in.	1 ft. 2½ in.
12	9¼ in.	1 ft. 3¾ in.
13	7⅞ in.	1 ft. 5 in.
14	8½ in.	1 ft. 6⅜ in.

Further information on lining curves and laying out easement curves with a string, and examples for laying out curves to reach industry sidings are given in "Simplified Curve and Switch Work," by W. F. Rench; published by the Railway Educational Press, Inc., Chicago.

GLOSSARY OF TRACK TERMS.

The words in this glossary have been collected largely from the personal experience of the author, and some of them are undoubtedly local. The words refer specifically to track, and may have meanings totally different in other trades or vocations. Furthermore, a list such as this is susceptible of constant additions and is not expected to be complete. The author solicits additions from practical track men. Several definitions are taken from the manual of the American Railway Engineering Association.

Adjustable switch rod, n.—A head rod carrying a device for varying the distance between the switch rails.

Air-line, n.—A main line having highest class gradient, alinement, roadbed and track.

Alinement, n.—The horizontal location of a railroad with reference to curves and tangents.

Angle bar, n.—

See (1) Compromise angle bar.
(2) Continuous angle bar.
(3) L. & S. angle bar.
(4) Long-and-short angle bar.
(5) Long punch angle bar.
(6) Offset angle bar.
(7) Short punch angle bar.
(8) Step angle bar.

Apron, n.—A short wide piece of sheet iron placed between two ballast cars with its ends on the floors, to prevent ballast from falling on the track when unloading with a dirt plow.

Armstrong, n.—A speeder. A hand car on which the operator remains seated as he propels the car.

Assisting grade, n.—The inclination given to tracks of a yard to facilitate the movement of cars.

Automatic switch stand, n.—A switch stand which will throw automatically and allow a trailing train movement without damage, when the switch is lined up for the wrong track.

Backing, n.—(1) Rough stones used on the back of a masonry wall; (2) Gravel or filling behind a wall or abutment.

Ball, n.—"Ball of rail." The top heavy portion of the rail on which the wheels run.

Ballast, v. t.—To raise a track, tamping and filling with ballast.

Ballast, n.—Selected material placed on the roadbed for the purpose of holding the track in line and surface.

Ballast, n.—

See (1) Broken stone.
(2) Burnt clay.
(3) Chats.
(4) Chert.
(5) Cinders.
(6) Disintegrated granite.
(7) Gravel.
(8) Slag.
(9) Stone.

Ballast plow, n.—(1) A plow for unloading ballast from cars; (2) A plow for spreading ballast which has been dumped in the center of a track.

Ballast stake, n.—An engineer's stake set so that the top is at the height the rail is to be when the track is surfaced.

Ball'er, v. t.—A command to the rail gang, holding a rail, to turn the ball toward their bodies.

Ball-worn, adj.—"Ball worn rail." A rail on which the ball has been badly worn.

Banner, n.—The target of a switch stand.

Base, n.—"Base of rail." The flat, bottom part of a rail which sets on the ties.

Battered, adj.—"Battered rail." A rail the end of which has been pounded and flattened by passing wheels.

Belt, n.—A line built around a city, for the local distribution of freight.

Bend, v. t.—"Bend the rails." To throw a switch.

Bent, n.—The piles and cap, or trestle work, which supports bridge stringers.

Berme, n.—An approximately horizontal surface for the protection of the slope between the top or toe of a slope and a boundary line, ditch, or other excavation.

Blade, n.—That part of a signal arm which, by its form and positions, gives the day signal indications.

Blade, v. t.—"To blade-in ballast." To shove stone ballast under the ties with shovels.

Block, n.—A length of track of defined limits, the use of which by trains is controlled by block signals.

Block, n.—

See (1) Expansion block.
(2) Filler block.
(3) Heel block.
(4) Nipping block.
(5) Spot board blocks.

Block signal, n.—A fixed signal controlling the use of a block.

Block station, n.—A place from which block signals are operated.

Block system, n.—A series of consecutive blocks.

Blow, v. i.—A hobo term meaning to quit the job, and to leave that section of the country.

Blow, v. i.—To "blow-in." A hobo term meaning to arrive.

Board, n.—A semaphore signal.

Body track, n.—Each of the parallel tracks of a yard or group of tracks upon which cars are switched or stored.

Bohunks, n.—Austrians, Polacks, or Bohemians.

Boil, v. t.—To "boil up." To wash clothes, blankets, etc.

Bolted frog, n.—A frog in which the point and wing rails are held together by bolts.

Bond, v. t.—To connect two track rails together by wire at the joint so that an electric current may pass around the joint.

Bond wires, n.—The short wires used in bonding a joint.

Bonded joint, n.—A rail joint past which an electric current is carried by bond wires.

Boot-leg, n.—The part of a line of trunking which dips to pass under a rail or other obstruction.

Borrow, v. t.—(1) To take material from a borrow pit; (2) **n.**—Material removed from a borrow pit.

Borrow pit, n.—An excavation made for the purpose of obtaining material for a fill or embankment.

Bounding post, n.—A post marking the division line between right-of-way and other property. Same as "boundary post."

Branch line, n.—A line of lesser importance, leading off from main line.

Brass collar, n.—An official.

Break, v. t.—"To break track." See cut, "to cut track."

Break up, v. t.—"To break up a train." To switch out or make a new distribution of the cars in a train.

Break up, n.—A track or tracks where trains are broken up.

Bridge joint, n.—A suspended joint. A rail joint which is supported by one tie under each end of the joint fastenings, but which has no tie directly beneath the meeting point of the rails.

Bridge sign, n.—A small board on which the bridge number is painted.

Bridle box, n.—A box for carrying bridle rods (taken off behind track machines) ahead on a track-laying machine. The box is placed in the tie trams.

Bridle man, n.—A man who places bridle rods on the rails ahead of a track laying machine.

Bridle rod, n.—A rod with the ends turned up to hook over the outsides of the rail bases, and hold unspiked rails to gage; also used to prevent spiked rails from spreading.

Broken joints, n.—Rail joints which are not opposite each other in a track.

Broken stone, n.—Stone broken by artificial means into small fragments of specified sizes, for ballast.

Broomed rail, n.—A rail the ball of which has been crushed and flattened in spots.

Bubble man, n.—The man who carries the level when surfacing track.

Buck, v. t.—(1) To move a string of rails by hitting the end of the string with another rail used as a ram; the rail is launched endways by a number of men, and delivers a sharp horizontal blow; (2) To set the end of a rail, a switch point or a frog, against the end of another rail already set up.

Buck, v. t.—"Bucking ties." Carrying out and distributing ties ahead of a track laying machine.

Buck, v. t.—"To buck up expansion." To decrease the expansion spaces in a track, by bucking up the rails.

Bulk head, n.—A wall of wooden timbers behind which dirt is confined or retained.

Bull dozer, n.—A large plow attached to the side of a car, used for leveling off piles of dirt at the side of a track.

Bum, v. t.—(1) To ride over the country without paying fare. (2) "To bum a lunch." To beg a lunch.

Bump, v. t.—To "bump a man." To displace a man on a job.

Bumping post, n.—A post anchored and braced at the end of a stub track to stop cars or engines from running off the end of the track.

Burnt clay, n.—A clay or gumbo which has been burned into material for ballast.

Butcher, n.—"Bridge butcher." A bridge workman.

Butcher, n.—"Track butcher." A track workman.

Car, n.—

See (1) Ballast car.
(2) Dump car.
(3) Trimmed car.

Cant, v. t.—"Canted rail." A track rail which is tipped, so that it does not set perpendicular.

Canary, n.—A section-foreman.

Cap, n.—(1) A torpedo; (2) the top timber of a bridge bent.

Cast, v. t.—"To cast dirt." To throw dirt several feet with shovels.

Catch siding, n.—An upgrade side track used in mountainous countries, normally lined up to side-track runaway trains or cars.

Cattle guard, n.—A device placed between the rails and used in connection with wing fences to prevent cattle from passing inside the right-of-way.

Center frog, n.—The middle frog in a three throw switch.

Center line, n.—A line marking the center of an excavation, embankment or of a track.

Center plow, n.—A dirt plow which plows the dirt or ballast off of a train, delivering it on both sides of the track.

Center punch, n.—A pointed tool, used to mark the center point where a bolt hole is to be drilled.

Center stakes, n.—Stakes marking the center line.

Centerbound, adj.—The condition of a track where the ties are tamped so solidly in the center that little of the weight of trains is borne by the ends of the ties.

Centers (track centers).—The distance between the gage sides of corresponding rails on parallel tracks.

Channel switch, n.—A split switch, to the points of which guard rail stiffeners are attached.

Chats, n.—Tailings from mills in which zinc and lead ores are separated from the rocks in which they occur; used for ballast.

Checks, n.—Small cracks in the wood of a tie caused by seasoning.

Chert, n.—An impure flint or hornstone, occurring in beds, used for ballast.

Cinders, n.—The residue from the coal used in locomotives or furnaces.

Cinder track, n.—(1) A track ballasted with cinders; (2) A track on which cars are placed to be loaded with cinders.

Clamp, n.—"Switch point clamp." A device for clamping safely the temporary switch point connection used in relaying track.

Clamp frog, n.—A frog in which the different parts are held together with clamps and keys.

Clamp gage, n.—A notched tool for holding rails to gage for the iron car while laying steel.

Classification yard, n.—A yard adjoining a separating yard, in which cars are classified or grouped in accordance with requirements, preliminary to forwarding in trains.

Clean break, n.—A rail which has been cut and broken so that it shows smooth, squarely broken end surfaces.

Clear, n.—Beyond the reach of moving trains. To "get in the clear." To get off the main line, leaving it clear for other trains.

Clearance, n.—Distance beyond the extreme outside line of moving trains, to the nearest point on a building or other obstruction.

Clearance post, n.—A post set at point of clearance on converging tracks.

Close, v. t.—"To close-up track." To put in connections, or to make continuous a track which has been disconnected. See "connection."

Cluster or general yard, n.—An arrangement of yards in series for the separation, classification, assembling and storage of cars.

Compound curve, n.—A change of direction consisting of two or more simple curves of different radii, all in the same direction, joining one another at points with common tangent.

Compromise angle bar, n.—Same as "step angle bar" or "offset angle bar." An angle bar designed to make a smooth joint of two rails of different size.

Compromise joint, n.—Same as "step joint." A joint between two rails of different sizes.

Connection, n.—To "make a connection"; to close up, or make continuous, a track which is disconnected.

Continuous angle bar, n.—(1) A combined angle bar and base plate. (2) An angle bar which has a flat base portion extending under the rail.

Continuous plate, n.—Used same as "gage plate." A tie plate reaching clear across a tie, or under two or more rails.

Corduroy track, n.—Track layed on brush or logs across a swamp or marsh.

Cotter, n.—See key. A pin which is placed in a hole provided for that purpose in a bolt, to prevent the nut from turning off.

Creeping, inf.—"Creeping rails." Track rails which are moving longitudinally.

Crib, v. t.—To build a temporary track foundation, consisting of timbers placed systematically upon others, forming a substantial structure.

Crib, n.—A temporary track foundation built of timbers built up systematically one on the other, to form a substantial structure.

Cribbing, n.—Same as "crib."

Crossing frogs, n.—Frogs placed where two tracks cross.

Crossover, n.—Two oppositely facing turnouts from adjacent tracks, connected to each other.

Crossover track, n.—A track connecting two adjacent tracks.

Cross-tie, n.—That transverse member of a railway track which supports the rails and by means of which they are retained in position.

Crotch frog, n.—A switch frog used where both leads are curved and the curves continue behind the frog.

Crowd, v. t.—"To crowd men." To hurry up or "drive" a gang of men.

Cull tie, n.—A second-class tie. A tie which has been culled out from first-class ties.

Curve, n.—A change in direction by means of one or more radii.

Curve, n.—See (1) Compound curve. (2) Easement curve. (3) Heavy curve. (4) Reverse curve. (5) Sharp curve. (6) Simple curve. (7) Spiral curve. (8) Vertical curve.

Curve monument, n.—A permanent mark set at the point of a curve, on which information is given as to degrees, elevation, etc.

Curve sign, n.—Same as "curve monument."

Cut, v. t.—"To cut in a connection." (1) To put in a switch. (2) To cut and place rails to form a track connection between the old and new rails, when relaying track.

Cut, v. t.—"To cut track." To disconnect the rails of a track.

Cut-off, n.—A track which shortens the original line.

Dead end, n.—The end of a stub track.

Dead head, v. i.—To ride on free transportation.

Dead head, n.—(1) An obstruction placed at the end of a stub track to prevent cars running off. (2) A passenger riding on free transportation.

Dead man, n.—(1) A buried timber to which a guy rope or block and tackle is anchored, or against which a brace is placed; (2) A fraudulent name carried on a payroll for which there is no laborer in the crew.

Dead rail, n.—Any rail in a track which does not regularly receive the direct bearing of wheels.

Dead track, n.—A disconnected piece of track, over which trains cannot be operated.

Departure or forwarding yard, n.—A yard in which cars are assembled in trains for forwarding.

Derail, n.—An appliance for throwing a locomotive off the track should the engineer disregard a danger signal.

Detector bar, n.—A bar placed at a switch or derail alongside of and normally below the top of rail, operated in connection with a facing point lock, derailing device, or switch, or so that its operation, and consequently that of the lock, will be prevented by the presence of any of the wheels of the train.

Dinky, n.—(1) A short local passenger train. (2) The stationary engine on the pioneer car of a track laying machine. (3) A narrow gage locomotive. (4) A small standard gage locomotive.

Dinky-skinner, n.—(1) The engineer who controls the live rollers and through them the speed of the ties and rails, in the trams of a track laying machine. (2) The engineer of a narrow gage locomotive.

Dirt track, n.—Same as "mud track." A track surfaced with dirt.

Disintegrated granite, n.—A natural deposit of granite formation, which, on removal from its bed by blasting or otherwise, breaks into particles of size suitable for ballast.

Distribution track, n.—(1) A track in a material yard from which different kinds of material are unloaded and piled. (2) A track in a freight yard where cars are stored ready for distribution to industry tracks, or for transfer to other roads.

Doty tie, n.—A tie affected by fungous growth.

Double slip switch, n.—A crossing of two tracks with two curved track connections affording two routes for passing from one track to another.

Double-up, v. t.—To combine two or several track gangs.

Drag, v. i.—To quit work in order to obtain wages which are due with the idea of returning to work after the money is procured.

Draw, v. t.—To "draw a rail in." To move a rail laterally in driving the spike home.

Dress, v. t.—To "dress up track." To fill in and smooth up the ballast between and at the ends of the ties, and to build shoulder.

Drift bolt, n.—(1) A bolt which is driven through two or more heavy timbers, to bind them together. (2) A bolt used for holding caps and stringers in place.

Drill track, n.—A track connecting with the ladder track, which is kept clear for movements in yard switching.

Drive, v. t.—To "drive a spike home." To drive a spike far enough to make the head rest snugly against the base of the rail.

Drive, v. t.—"To drive expansion." To close or open up the expansion openings at rail joints.

Drop, v. t.—"To drop a tie." To skip a tie.

Dump, n.—A fill or embankment.

Dump, v. t.—(1) To unload dirt or ballast. (2) To unload a ballast car, a dump car, or a dump wagon. (3) to release the automatic device on a dump car or wagon, so that the dirt is unloaded.

Dump car, n.—Same as "dumpy" or "leary." A four-wheeled flat bottomed car used by laborers for moving track or other material.

Dump wagon, n.—A wagon used in grading, having an automatic device for unloading or dumping material through the bottom.

Dump, n.—Same as "dump car," or "leary."

Dust, v. t.—"To dust a rail." To raise up and drop a rail repeatedly in order to remove sand, ice, or other loose material from its surface.

Dutchman, n.—(So called because you can't get an Irishman in such a tight place). (1) A piece of rail a few inches long used to fill an opening between the ends of track rails. (2) Any short piece of rail.

Easement curve, n.—Similar to "spiral curve." A curve of regularly varying radii connecting a tangent to a simple curve, or connecting two simple curves.

Eagle eye, n.—A locomotive engineer.

Elevation, n. (as applied to curves).—The amount which the outer rail is raised above the inner rail.

Elevation, n.—"Running in" elevation. Gradually raising one rail above the other, when approaching a curve.

Elevation, n.—"Running out" elevation. Gradually bringing the track back to level after emerging from a curve.

Embankment, n.—A fill. A bank of earth or other material constructed above the natural ground surface.

Emergency, n.—The emergency air brake.

Endo, v. t.—A command meaning to move a rail, or other heavy object endways.

Engine, n.—"Dummy engine." A small locomotive used in industrial plants or on construction work.

Excavation, n.—(1) The material taken from cuts, borrow pits, or foundation pits. (2) The hole left after removing material.

Expansion, n.—The space for longitudinal movements at the rail joints in a track, necessary on account of change of length of rails with change of temperature.

Expansion block, n.—Same as "expansion plug." A piece of rail used to close a gap between the ends of two rails in a track. Its length may be from a fraction of an inch to several inches.

Expansion plug, n.—Same as "expansion block."

Extra gang, n.—A transient gang which is employed on other than regular section work; usually a large gang.

Eye, n.—The space between ties on the outside of the rail.

Facing point, n.—A switch or frog which points against the movement of trains.

Farmer, n.—A person with no experience in railroad work.

Fastenings, n.—"Track fastenings." Splices, bolts and spikes. "Auxiliary fastenings."—Nutlocks, tie-plates, rail braces, and anti-creeping devices.

Feeder, n.—A branch line.

Fiddle, n.—An instrument for marking the proper position on ties, for the edge of the base of rail.

Fiddle, v. t.—To put chalk marks across the upper face of a tie on the line side, using the "fiddle."

Fiddler, n.—The laborer who fiddles ties.

Fill, n.—Same as "embankment.."

Filling, n.—Material used in making embankments.

Filler block, n.—A casting placed between the guard rail and main line rail. The thickness of the block is adjustable or is such that the guard rail will be in its proper lateral position when resting snugly against this block.

Finisher, n.—A man who levels off the grade behind the grading gang.

Finishing stakes, n.—Final stakes set for the completion of the work.

Fish plate, n.—A flat piece of iron with holes drilled in it, used for making a joint between two rails. Distinguished from an angle bar by being perfectly flat, and resting against the web of the rail only.

Fixed signal, n.—A signal in which the arm or disc is stationary, and can give but one indication.

Flange, n.—The part of the base of rail on one side of the web; the rail has two flanges, but only one base.

Flanger, n.—A machine provided with small plows for removing snow and ice from the gage side of rails.

Flanger sign, n.—A sign board and standard symbol, denoting an obstruction in the track ahead, to pass which the flanger plows must be raised.

Flange-way, n.—(1) The space between a guard rail or crossing plank, and the main rail; (2) The space between the wing of the frog and the running rail.

Flatten, v. t.—To "flatten a curve." To reduce the degree of curvature.

Foot guard, n.—A wooden block or metal appliance used in switches to prevent the feet of employes being caught and wedged in the frog or back of the switch rails.

Foreman.—"Extra gang foreman." The man in charge of an extra gang of laborers.

Foreman, n.—"Section foreman." The foreman of a crew of men in charge of and responsible for the maintenance of a section of track and right-of-way.

Fork, n.—See Rail Fork.

Freight yard, n.—A railroad yard where freight cars are stored and freight trains are made up.

Frog, n.—A frog is a union of two rails which cross each other in such a manner that a wheel rolling along either rail will have an unobstructed flangeway while passing the other rail. (Camp.)

Frog, n.—See (1) Bolted frog. (2) Center frog. (3) Clamp frog. (4) Crossing frog. (5) Crotch frog. (6) Movable point frog. (7) Plate frog. (8) Rigid frog. (9) Solid center frog. (10) Special frog. (11) Spring rail frog.

Front, n.—The extreme end of a track under construction.

Frost plow, n.—A heavily constructed plow used in winter grading work for breaking up frozen earth.

Frost spike, n.—A track spike longer than the ordinary spike, for use in shimmed track.

Fudge, v. t.—To put in a piece of work which is contrary to standard, but which is made to fit approximately and fulfill the required conditions.

Gage, n. (of track).—The distance between the heads of the rails measured at right angles thereto at a point 5/8-in. below the top of the rail.

Gage, n.—"Standard gage." The gage of 4 ft. 8½ ins.

Gage, n.—See (1) Clamp gage. (2) Tie plate gage. (3) Tight gage. (4) Track gage. (5) Wide gage.

Gage bearer, n.—A laborer who carries the clamp-gage ahead of the rail car.

Gage plate, n.—A "continuous plate." A slide plate extending clear across the tie, and provided with braces which rigidly hold the rails to gage.

Gauntlet track, n.—A track, one rail of which lies between two rails of a main track. It may leave the main track by a switch; a gauntlet track may lead off from a side track, the middle rail entering and leaving the center of the main track by use of frogs.

General foreman, n.—A foreman who has charge of all the work and laborers, on a construction job.

Ginny, n.—A foreigner.

Grade, v. i.—To prepare the ground for the reception of the ballast and track.

Grade, n.—Ground which has been prepared to receive ballast and track.

Grade crossing, n.—A crossing in which both roads are at the same level or elevation.

Grade line, n.—The line on the profile representing the tops of embankments and bottoms of cuts ready to receive the ballast.

Grade stake, n.—A stake set with the top at the correct height for the track.

Gradient, n.—The rate of inclination of the grade-line from the horizontal.

Grading machine, n.—A large plow, attached to a machine with endless apron carriers for excavating and throwing dirt onto a grade, or into dump wagons.

Grass line, n.—A defined line of vegetation on the shoulder of embankment. The space between the grass line and the track is kept free from weeds and grass.

Gravel, n.—Small worn fragments of rock, coarser than sand, occurring in natural deposits.

Gravel train, n.—A train carrying gravel for ballast.

Gravity yard, n.—A yard in which the separation or classification of cars is aided by gravity. The movement of cars to yard tracks is accomplished by pushing the cars up to the top of a hump, where they are released and run down hill to the desired spot.

Greenhorn, n.—A man inexperienced in track work.

Grief, n.—Difficulties encountered and caustic criticism from superior officers.

Ground switch stand, n.—Same as "jack knife switch stand." A simple lever stand, without target, the handle of which lays flat on the head blocks when the switch is closed.

Gumbo, n.—A term commonly used for a peculiarly tenacious clay, containing no sand.

H. B. (head block), n.—Used interchangeably with P. S. to denote the position for the switch point.

Half round tie, n.—A slabbed tie having greater width on lower than on top face.

Hand out, n.—A free lunch or meal.

Hang, v. t.—To "hang angle bars." To place a pair of angle bars on the head end of a rail, when laying it in the track, bolting loosely with only one bolt.

Hard-center frog, n.—A frog with a manganese steel insert at and around the point.

Hardy, n.—A rail chisel. See track chisel.

Head, n.—"Head of rail." Same as "ball of rail."

Head block.—The long tie or ties to which the switch stand is spiked.

Head rod, n.—Same as "number one" rod. The switch rod nearest the point of switch.

Heart tie, n.—A tie showing sapwood on one or two corners only, which sapwood does not measure more than one inch on either corner, on lines drawn diagonally across the end of tie.

Heavy curve, n.—Same as "sharp curve." A curve which has a high degree of curvature.

Heel, n.—(1) The end of the rail being placed, which will rest against the end of the rail previously laid. (2) The end of a

switch rail. (3) The end of a frog farthest from the switch point. (4) Anything used as a fulcrum under a bar.

Heel block, n.—A casting used in the joint at the heel of the switch point rail.

Heel casting, n.—Same as "heel block."

Heel-in, v. t.—To "heel-in" a rail, frog or switch point. To place the end of the rail, frog or switch point against the end of a rail in the track.

Heel plate n.—A plate used under the joint at the heel of the switch rail.

Heeler, n.—The man who, in laying track, gives the commands, and directs the placing of the heel of each rail in the angle bars.

Hewed tie, n.—A tie hewed on at least two sides.

High.—A command given to jack men when raising to indicate that the track has reached the required height.

High spiker, n.—A spiker who follows a spiking gang, and drives spikes down which have not been driven home.

High switch stand, n.—A switch stand with a high target, generally used for main line.

Hip heeler, n.—The laborer who works next to the heeler.

Hobo, n.—An itinerant track laborer, who makes a practice of travelling around the country, working temporarily on extra gangs.

Hogger, n.—A locomotive engineer.

Hog head, n.—A locomotive engineer.

Hold, v. t.—"To hold a train." To stop a train or delay it.

Holding power, n.—The "holding power" of a tie. The resistance a tie offers to a spike to prevent spreading of the rails.

Home block signal, n.—A fixed signal at the entrance of a block, to control trains in entering and using the block.

House track, n.—(1) A track alongside or entering a freight house and used for cars receiving or delivering freight. (2) A track running alongside a freight house. (3) A track leading to an engine house.

Industry track, n.—A track leading to a factory or manufacturing plant.

Insulated joint, n.—A track joint designed to stop the flow of an electric current from one rail to the next.

Interlocking machine, n.—The primary operating or controlling mechanism of an interlocking plant, placed in the interlocking station, and in which the interlocking feature is effected.

Interlocking plant, n.—An arrangement of switch, lock and signal appliances so interconnected or interlocked that one movement must succeed another in a predetermined order.

Intermediate switch, n.—A switch which does not connect directly with the ladder track, but leads off from a primary track which does connect with the ladder track. The intermediate switch points are located just behind the frog of the primary track.

Intermediate switch stand, n.—A stand whose target is at a height intermediate between a high and a low switch stand. Generally used in yards.

Iron, n.—Track rails.

Iron car, n.—A four-wheeled car propelled by men or horses, used for carrying rails when laying track.

Jack, n.—A car without air brakes.

Jack, n.—"Track jack." An instrument used for raising track.

Jack knife switch stand, n.—Same as "ground stand."

Jerry, n.—An Irish track laborer.

Jim, v. t.—To spoil or render unfit for use.

Jimmed, adj.—Spoilt or injured.

Jim crow, n.—A rail bender, designed only to give a rail a kink or angle at one point.

Joint, n.—See (1) Bonded joint. (2) Bridge joint. (3) Broken joint. (4) Compromise joint. (5) Insulated joint. (6) Mock joint. (7) Offset joint. (8) Square joint. (9) Step joint. (10) Supported joint. (11) Suspended joint. (12) Three-tie joint.

Junction sign, n.—A warning sign placed a standard distance from a railway crossing or junction.

Junk line, n.—A railroad line containing old and poor material, and in poor running condition.

Key, n.—An iron pin which is placed through a hole in the end of a bolt, in order to hold the nut on. The pin is split, the two parts are spread after inserting in the hole, and the key is thus prevented from coming out.

Kill, v. t.—"To kill a track." To disconnect a track so that it cannot be used.

King-snipe, n.—A section foreman.

Kink, n.—A short piece of track which is out of line.

L. & S. angle bar, n.—Same as "long and short angle bar."

Ladder track, n.—A track connecting in series the body tracks of a yard.

Lagging, n.—Same as "sheathing." Boards braced against the sides of earthen excavations, etc., to prevent cave-ins.

Launch, v. t.—To slide. To move endways.

Lead, n.—(1) Distance from point of switch to point of frog. (2) A ladder track.

Lead track, n.—An extended track connecting either end of a yard with the main line.

Leary, n.—Same as "dumpy" or "push car."

Level, n.—The condition of the track in which the elevation of the rails transversely is equal.

Lift rails, n.—(1) Rails used at ends of drawbridges, which are lifted up when the bridge is to be opened. (2) Rails in a lift-rail switch which lay up against main line rails when a switch is thrown for side track; these rails gradually elevate the wheels until the flanges are carried up over the main line rails.

Line, n.—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

Line, v. t.—(1) To line track. To put track in a desired, or the proper position. (2) To line up switches. To throw one or several switches so that a desired route is obtained.

Line, n.—(1) A railroad. (2) A route on a railroad.

Line bent.—"Line bent rail." A rail which has been bent laterally, and retains a permanent set.

Line man, n.—The man who stretches the tie line ahead of the tie spacers in a track laying gang.

Liner, n.—(1) A foreman engaged in lining track. The laborers are also frequently called liners. (2) Gage liner. The laborer who throws the rail into position for the gage spikers.

Lip, n.—A lateral projection of a rail end at a joint.

Live rail, n.—Same as running rail. The rails of a track scale on which cars are placed for weighing.

Loading track, n.—A track on which cars are placed to take on a load.

Lock-nut, n.—A nut so designed that when tightened it strongly resists loosening.

Long and short angle bar, n.—Same as L. & S. angle bar. An angle bar with a long punch on one end and a short punch on the other, to fit two differently drilled rails.

Long punch angle bar, n.—An angle bar with the maximum distance between punch holes, where a railway has several standard distances.

Low switch stand, n.—A stand with a low target, and a lever which rests on the ties when the switch is closed. For use in yards.

Machine, n.—A track laying machine.

Main line, n.—The principal track in any district over which trains are operated.

Make up, v. t.—To "make up a train." To place cars intended for a certain train in their proper order on a track.

Material yard, n.—A yard used for storing materials to be used in laying a stretch of track, or a freight or passenger yard.

Monkey, n.—The hammer of a pile driver.

Mormon, n.—A scraper made of wooden planks with a steel tip. For pulling dirt down a bank or finishing top of grade.

Movable point frog, n.—A device for providing a continuous rail alternately for either of two intersecting routes.

Muckers, n.—Laborers engaged in excavating.

Mud, v. t.—A word used by a man in a lining gang to call for a new hold.

Mud sill, n.—A heavy timber imbedded in the earth at the end of an embankment, to form a support for stringers.

Mud track, n.—Same as "dirt track." Track surfaced with dirt.

Neck, n.—"Neck of a frog." Same as "throat of a frog."

Nip, v. t.—To raise with a bar.

Nipper, n.—A man detailed to nip up ties for a gang of spikers.

Nipping block, n.—A piece of wood used as a fulcrum in nipping up ties for a spiking gang.

No. 2, n.—A dirt shovel.

Offset angle bar, n.—Same as "compromise angle bar" or "step angle bar." An angle bar designed to connect smoothly two rails of different size.

Old man, n.—(1) A device for holding a ratchet rail drill in position. (2) A ratchet drill. (3) A man in charge of a number of gangs of laborers, or the official at the head of a department.

Open track, n.—A track reserved for movements through a yard.

P. C.—Point of curve.

P. C. C.—Point of compound curve.

P. E.—Point of easement curve.

P. F.—Point of frog.

P. R. C.—Point of reverse curve.

P. S.—Point of switch.

P. T.—Point of tangent.

Panel, n.—A rail length of track.

Paper collars, n.—Officials.

Passenger yard, n.—A railway yard in which passenger equipment is kept.

Passing siding, n.—A special siding, usually connected with the main track at both ends, and used to enable trains to pass each other.

Passing track, n.—Same as "passing siding."

Pecky tie, n.—A tie made from a cypress tree affected with a fungous disease, known locally as peck.

Peddle, v. t.—To distribute track material.

Peddler, n.—A man who distributes track material.

Peddler, n.—A traveling representative of a railway supply company.

Penstock, n.—An arrangement for supplying locomotive tanks with water. It consists of a pipe with a pivoted spout which may be swung out over the engine tank. The water is supplied under pressure and is controlled by a valve.

Pick, v. t.—"To pick up track." To surface track.

Pick, v. t.—"To pick up low joints." To raise low joints.

Pickled tie, n.—Same as treated tie. A tie which has been subjected to a process for preserving it from decay.

Pickeroon, n.—A small sharp pick used in rolling ties into the trams of a track-laying machine.

Pile plank, n.—A plank driven in the ground in the same manner as a pile.

Pinch, v. t.—"Pinch a car." To move a car by using a pinch bar.

Pioneer car, n.—The head car in a track-laying machine, on which the engine for operating the track machine is carried.

Piped, adj.—"Piped rail." A rail which splits in use; more especially a rail which splits at some point other than the end.

Pipe run, n.—An assemblage of pipe lines of an interlocking plant, with their carriers and foundations, in a common course.

Pipe wrench, n.—A track wrench over the handle of which a piece of iron pipe is driven, in order to lengthen the handle.

Pit, n.—See (1) Borrow pit. (2) Cinder pit.

Pit track, n.—(1) The loading track in a gravel or sand pit. (2) Track on which cars are placed for loading cinders from a cinder pit at a roundhouse.

Plan, n.—A drawing furnished for the guidance of work.

Plate, n.—See (1) Continuous plate. (2) Gage plate. (3) Heel plate. (4) Slide plate. (5) Tie plate.

Plate frog, n.—A frog in which the different parts are riveted to a heavy base plate.

Plow, n.—See (1) Ballast plow. (2) Bull dozer. (3) Center plow. (4) Frost plow. (5) Side plow. (6) Spreader.

Plug, n.—(1) A short railway branch line; (2) A local passenger train; (3) Anything to fill a hole.

Point, n.—(1) "Theoretical point of frog." The imaginary point where the gage lines of a frog intersect. (2) "Actual frog point." The end of the metal at the converging gage lines. (See also P. C., P. C. C., P. E., P. F., P. E., P. R. C., P. S., and P. T.)

Pole man, n.—The man who handles the rail derrick on the head end of the track machine.

Pole tie, n.—A tie made from a tree of such size that not more than one tie can be made from a section. Such a tie generally shows sapwood on two sides.

Policing.—"Policing the right of way." General cleaning up of right of way.

Pollock, n.—A Polander.

Poling yard, n.—A yard in which the movement of cars is pro-

duced by the use of a pole or stake operated by an engine on an adjoining parallel track. The movement may be facilitated by an assisting grade.

Post, n.—"Whistling post." A post with a standard sign on it, showing that there is a grade crossing or other dangerous place ahead, for which the engineer should sound the whistle as a warning.

Profile, n.—The intersection of a longitudinal vertical plane with the ground or established gradients; or a drawing representing same.

Pumping track, n.—Track where the ties work up and down excessively in wet ballast.

Pumpkin vine, n.—A railroad containing many sharp curves.

Push car, n.—Same as a "dumpy" or "dump car."

Puzzle switch, n.—A double slip switch.

Quartered tie, n.—A tie made from a tree of such size that four ties only are made from a section.

Rail, n.—Rail, used as a collective noun for plural.

Rail, n.—See (1) Ball worn rail. (2) Battered rail. (3) Broomed rail. (4) Lift rail. (5) Line bent rail. (6) Live rail. (7) Piped rail. (8) Ravelled rail. (9) Receiving rail. (10) Running rail. (11) Skid rail. (12) Stock rail. (13) Surface bent rail. (14) Taper rail. (15) Third rail. (16) Wing rail.

Rail bender, n.—A tool for giving a rail a uniform curve from end to end.

Rail brace, n.—A device to be spiked against the outside of a rail to prevent track from spreading or to hold guard rails in position.

Rail cut, adj.—"Rail cut tie." A tie which a rail has sunk into.

Rail fork, n.—A fork shaped tool used in turning and handling loose nails.

Rail nipper, n.—A man in a track laying gang who raises the rail which is already in position, in order to facilitate heeling in the next rail.

Rail plug, n.—Same as "expansion plug."

Rail rests, n.—Supports for holding one or more rails a sufficient height above ground to prevent their being covered with snow.

Rail square, n.—A wooden square used to determine whether joints in a track are in correct relative positions.

Rail-wear, n.—The deterioration of a rail caused by passing trains.

Railroad, v. t.—(1) To move a stationary engine by an anchor line and drum or winch. (2) To accomplish a large amount of work. (3) An exclamation or warning to denote the approach of a train, or to warn of any danger.

Ram, n.—The hammer of a pile-driver.

Ravelled rail, n.—A defective rail which has been worn by the passage of wheels so that small ragged strips protrude outward from the ball.

Receiving rail, n.—The rail, at a joint on a one-way track, on which the wheels drop in the direction of traffic.

Receiving tracks, n.—Tracks which are used for incoming trains.

Receiving yard, n.—A yard for receiving incoming trains.

Re-gage, v. t.—To draw the spikes on a track, and respike it to standard gage.

Reinforcing bar, n.—A bar bolted or riveted to a switch rail to strengthen it.

Relaying, adj.—"Relaying gang."—A gang which is relaying track.

Relaying, adv.—Replacing worn track rails with new rails.

Relief track, n.—An extended passing siding, long enough to allow an inferior train to continue running while a superior train passes.

Rerail, v. t.—To put a car back onto the track, after it has been derailed.

Reverse curve, n.—Two curves in opposite directions in a continuous line joining at a common tangent point.

Right-of-way map, n.—A plat representing the actual location and dimensions of the property, rights or franchises that are owned or controlled by a railroad company.

Rigid frog, n.—A frog in which all parts are stationary.

Rigid switch stand, n.—A switch stand which allows for no emergency spring movement if the switch is run through.

Rip rap, v. t.—To cover a bank or embankment with riprap.

Riprap, n.—Stone placed on a bank or an embankment to protect same from stream washing.

Road, n.—"Hitting the road, hitting the gravel, hitting the dirt

or hitting the grit." Hobo terms, meaning to start out over the country.

Roadbed, n.—The finished surface of the roadway upon which the track and ballast rest.

Roadway, n.—That part of the right-of-way of a railroad prepared to receive the track.

Road grader, n.—A machine for leveling the top of a grade.

Roberts-man, n.—A hobo who has worked on a Roberts track-laying machine.

Rod, n.—See (1) Adjustable switch rod. (2) Bridle rod. (3) Head rod. (4) Number one rod. (5) Switch rod.

Rolling stock, n.—The cars and engines owned by a railroad.

Rough neck, n.—A brakeman or switchman.

Run, v. t.—To "run through a switch." To pass over the switch points (trailing) when they are not lined up for the route; if the stand is rigid either the stand or the switch will be put out of operation; if the stand is a spring stand, it will throw automatically.

Run around track, n.—A short track connected at either end with a main track; the run around track is kept clear so that a train may be spotted on the main track and the engine can run around it and couple on the other end.

Run-off, n.—(1) The part of a curve or tangent changing from level track to superelevation on a curve. (2) A temporary incline in a track from a higher part which has just been raised, to the old level.

Running rail, n.—A rail which receives the bearing of wheels.

Running surface, n.—Putting a track in a condition just good enough to prevent injuring of rails by slow traffic.

Running track, n.—A track reserved for movements through a cluster or general yard.

Rust eaters, n.—The rail gang. The men who handle rails in track construction.

Runway, n.—A plank or board passage way for wheel barrows.

Safety switch stand, n.—Same as "automatic switch stand."

Sag, n.—A dip or low section in a track.

Sand, n.—Any hard, granular, comminuted rock material, finer than gravel, and coarser than dust.

Sand hog, n.—A man who opens and dumps automatic ballast cars.

Sand siding, n.—A gauntlet track covered with sand, used in place of a derail. The sand exerts great resistance and soon stops a train.

Sap tie, n.—A tie which shows more than a prescribed amount of sap-wood in cross-section.

Sawed tie, n.—A tie having both faces and sides sawed.

Scale track, n.—A track leading to a scale for weighing cars.

Scissor bill, n.—(1) The name given by the hoboes to a local laborer working on an extra gang. (2) An officious person.

Scissors crossover, n.—A right-hand and a left-hand crossover connecting, and with middle points intersecting between, two parallel tracks.

Scoot, n.—A short local passenger train.

Score mark, n.—A mark made by the ax as an aid in hewing out a cross tie.

Scraper, n.—A large steel shovel-like appliance drawn by horses, and used for scraping up and moving dirt.

Scraper, n.—"Fresno scraper." A large slip for two or more teams.

Semaphore signal, n.—A signal for controlling train movements, consisting of a movable arm attached to a mast, the indications being given by the position of the arm.

Separating yard, n.—A yard adjoining a receiving yard, in which cars are separated according to district, commodity, or other required order.

Set, v. t.—"Set a spike." To place a spike vertically on a tie and tap lightly with the hammer, so that the spike will be in the proper position for driving.

Shakes, n.—Separations of the wood fiber of a tie, due to the action of the wind.

Shank, n.—(1) The body of a bolt. (2) The body of a spike.

Sharp curve, n.—Same as "heavy curve."

Sharp flange, n.—A wheel flange which has been worn thin, and is likely to cause a derailment.

Sheet, v. t.—To place and brace boards against an earthen bank to prevent caving in.

Sheet piling, n.—Planks driven to form a solid wall to support a bank and exclude water while excavating.

Sheeting, n.—Same as "lagging."

Shim, n.—"Expansion shim." A piece of iron inserted temporarily between the ends of rails in track laying, to make allowance for the expansion of the rails.

Shim, n.—"Track shims." Wooden blocks of varying thickness, for inserting between the base of rails and the ties; used to raise low places in a track in the winter time, when the ties are frozen in the ground.

Shim, v. t.—(1) To place surface shims under a track. (2) To place expansion shims between the ends of the rails when laying track.

Shim spike, n.—Same as "frost spike."

Shoe, n.—A device used to prevent sliding friction between the wheels of a car and the rails; used when ballast unloaded in center of track is being spread by means of track ties placed in front of and against the wheels of a car, and the car shoved ahead.

Shoo fly, v. t.—To build around an incompleted fill, cut, bridge, or tunnel.

Shoo fly, n.—A track built around an incompleted fill, cut, bridge, or tunnel.

Short punch angle bar, n.—An angle bar with the minimum standard distance between holes, where several different standards are used.

Shoulder, n.—The top part of the railroad embankment, from the end of the ties to the ballast border.

Shoulder, v. t.—To "shoulder up track." (1) To build and shape up the embankment outside the end of the track ties; (2) to build a shoulder.

Shunt, v. t.—To switch cars.

Shuttle-engine, n.—(1) An engine used in a hump yard to carry the brakeman to the top of the hump. (2) An engine which is run back and forth to try out the routes in a new interlocking plant.

Side plow, n.—A ballast plow which shoves the ballast all off on one side of the train.

Siding or side-track, n.—A long track, away from a yard, connected with the main or running track at one or both ends and used for the storage or irregular movement of cars or trains.

Siding, n.—See (1) Catch siding. (2) Passing siding. (3) Sand siding.

Side track, v. t.—To run a train in on a side track.

Sign, n.—A visible signal.

Sign, n.—See (1) Bridge sign. (2) Crossing sign. (3) Curve sign. (4) Flanger sign. (5) Junction sign.

Signal, n.—See (1) Advance block signal. (2) Block signal. (3) Distant block signal. (4) Fixed signal. (5) Home block signal. (6) Semaphore signal. (7) Tell tale signal. (8) Whip guard signal.

Simple curve, n.—A change in direction by means of a single radius.

Single slip switch, n.—A slip switch with only one curved track connection, thus affording only one route between the tracks which cross.

Skeleton track, n.—A track which has no filling between the ties.

Skid, v. t.—To move material over skids.

Skids, n.—Beams along which material is slid in unloading, loading or piling up material.

Skid rails, n.—Rails designed especially for use as skids, provided with hooks which fit the stake pockets of a flat car.

Skinner, n.—A teamster in a grading gang.

Slab tie, n.—A tie made from slabs.

Slabbed tie, n.—A tie sawed on top and bottom only.

Slag, n.—The waste product, in a more or less vitrified form, of furnaces for the reduction of ore; usually the product of a blast furnace. Used for ballast.

Slew, v. i. (Same as Slue).—To slide sideways out of position.

Slewed track, n.—Track which has slid out of line.

Slide plate, n.—A metal plate under a switch point, a movable frog point, or the spring rail of a frog, over which those devices slide in their lateral movements.

Slip, n.—(1) A dirt scraper used in grading. (2) A slip switch.

Slip switch, n.—A crossing of two railway tracks, and combined with it a curved track or tracks and switch points providing a route from one track to the other.

Slope, n.—The inclined face of a cut or embankment.

Slope stake, n.—A stake set to mark the top or bottom of a slope.

Sloper, n.—A laborer who finishes off the slope of an embankment or cut.

Slue.—(See "Slew").

Smoke, n.—Discarded core sand from an iron foundry, which is exceedingly fine, dry and dirty, and easily blown about by wind.

Smooth, v. t.—To "smooth up track." To raise the low places only, and rapidly put the track in fair shape.

Snipe, n.—A section hand.

Snipe up, v. t.—To go over a track, raising only the worst parts.

Snow fence, n.—A fence constructed to prevent snow drifting onto the right-of-way.

Soldier, v. t.—To kill time or to shirk.

Soldier, n.—One who shirks.

Solid center frog, n.—A frog in which point and wing rails are cast in one piece, and require neither frog bolts nor frog clamps.

Spacing, n.—The distance between centers of ties on a track.

Spear spike, v. t.—To omit part of the spikes on the inside of a track.

Special frog, n.—A frog made to fit into a special track layout, where no regular frog will fit.

Special tracks, n.—In a typical yard there will be several tracks devoted to special purposes, varying with the local conditions. These will include caboose tracks, scale tracks, coaling tracks, ash-pit tracks, bad-order tracks, repair tracks, icing tracks, feed tracks, stock tracks, transfer tracks, sand tracks, depressed tracks, etc.

Speeder, n.—Same as "armstrong."

Spike, n.—Used as a collective noun to denote plural.

Spike-killing.—The destruction of a tie on account of frequent driving and pulling of spikes.

Spike puller, n.—(1) A short claw-like tool designed to clutch a spike which is between a rail and a guard rail, and which cannot be reached by an ordinary claw bar. (2) A man who pulls spikes.

Spike-punch, n.—A blunt pointed instrument for driving down spike stubs so that they will be flush with or below the tie face.

Spike-slot, n.—A notch in an angle bar into which the spike is driven.

Spike throat, n.—The body of a spike just beneath the head, which rests against the rail base.

Spike-stub, n.—A spike with the head broken off.

Splices, n.—Angle bars or fish plates.

Split tie, n.—A tie made by splitting from a tree of such size that two or more ties can be made from a section.

Spiral curve, n.—Similar to "easement curve." A curve in which the degree of curvature is low at the points and gradually increases until the maximum degree is reached.

Spoon, n.—A shovel.

Spot, v. t.—To place cars. To move cars to a desired position.

Spot, n.—The black line on the spot board.

Spot, n.—Cars "on spot." Cars in the correct or desired position.

Spot-board, n.—A broad straight-edged board painted white, with a wide black line running across it transversely. Used in raising track to a definite height or grade.

Spot board blocks, n.—Blocks (used in raising track with the spot board) whose height is the same as the distance from the bottom of the spot board to the black line or "spot" on the board.

Spreader, n.—(1) Same as "bull dozer." (2) A center plow fastened to the under side of a car. Used for leveling off ballast which has been dumped in the middle of the track. (3) A car with wings for plowing or spreading out dirt dumped in the center and at the side of a track.

Spring rail frog, n.—A frog with a movable wing which rests against the frog point and takes part of the wheel load when a train passes on the main track. When taking the side track the movable wing is sprung out by the wheel flanges.

Spur, v. t.—To "spur out a car." To place a car on a short piece of track, all connection with other tracks to be broken after the car is in the desired position.

Spur track, n.—A stub track, usually leading to and serving an industry, or warehouse, freight house, etc.

Square joints, n.—Track joints which are directly opposite each other in the track.

Stake, n.—A specified amount of money which a hobo plans to save up before quitting the job.

Stake, n.—See (1) Ballast stake. (2) Center stake. (3) Finishing stake. (4) Grade stake. (5) Slope stake.

Station board, n.—A sign board about a mile from a station announcing the distance to the station.

Station-grounds, n.—Property to be used for station purposes.

Steel, n.—Track rails.

Steel-car. n.—(1) A small truck used to carry the rails when laying track. (2) The car containing the rails, in a track-laying machine.

Steel roller, n.—The man who rolls the rails into the trams on a track-laying machine.

Stem, n.—(1) The shaft in a switch stand. (2) The "main stem." The main line.

Step angle bar, n.—Same as "offset angle bar" or "compromise angle bar."

Step fish plate, n.—A fish plate designed to make a smooth joint of two rails of different size.

Step joint, n.—A joint between two rails of different size.

Stock-rail. n.—(1) The bent rail in a switch, against which the track switch rail rests when closed. (2) Either rail in a switch against which a switch rail may be thrown.

Stone ballast.—Crushed lime, or other suitable stone, used for ballast.

Stone train, n.—A train carrying crushed stone for ballast or concrete.

Stop block, n.—A block fastened to the back of a point, and which rests against the web of the track rail when a train is passing over the point; prevents switch rail from bending.

Storage yard, n.—A yard in which cars are held awaiting disposition.

Stormy-end, n.—The end of the rail which comes out of the track-laying machine first.

Strapper, n.—The man who hangs the angle bars on the head rails in laying track.

Straps, n.—Angle bars or fish plates.

Strap, n.—"Safety strap." A light strip of iron spiked to head block ties. The strap is bent so as to be beneath the connecting rod and prevents the latter from dropping down

and being disconnected in case the nut works off the crank on the switch stand.

Straw, n.—(1) An assistant foreman. (2) An overseer subordinate to the assistant foreman.

Straw, v. i.—To work as an assistant foreman.

Straw-boss, n.—Same as "straw."

Straw man, n.—A fraudulent name carried on the pay roll, for which there is no laborer in the crew.

Streak-of-rust, n.—A railway line.

Stretch, v. t.—"To stretch steel." (1) To provide for expansion in a tight track, by bucking the rails ahead towards a point where there is more expansion. (2) To set up rails.

Strict heart tie, n.—A tie having no sapwood.

Stringers, n.—The timbers laying longitudinally under, and supporting the track on a bridge.

Stripping, n.—Soil removed from the top of a gravel pit or quarry.

Stripping, n.—"Stripping out track." Removing the ballast from between the ties.

Stub switch, n.—A switch in which the stub ends of rails are moved transversely to shift the route of trains.

Stub track, n.—A short track connected with another at one end only.

Stuff, n.—Money.

Subgrade, n.—The tops of embankments and bottoms of cuts, ready to receive ballast.

Summit or hump yard, n.—A yard in which the movement of cars is produced by pushing them over a summit, beyond which they run by gravity. The movement from the base to the summit may be facilitated by an assisting grade.

Sun-kink, n.—A sharp crook in the track; caused by the heat of the sun expanding the rails until sufficient force is generated to throw the rails out of line.

Supported joint, n.—A rail joint which has a tie directly beneath the point of junction of the rails.

Surface, v. t.—To raise track to proper grade, or to a more or less smooth condition.

Surface, n.—The condition of the track as to vertical evenness or smoothness over short distances.

Surface, n.—"Skeleton surface." A temporary surface where no filling has been thrown between the ties.

Surface-bent, adj.—"Surface-bent rail." A rail which has been bent perpendicularly, and has taken a permanent set.

Suspended joint, n.—A rail joint with a tie under each end but having no tie directly below the junction of the rails.

Swing, n.—A piece of track designed to be tangent, which has moved to one side for a considerable distance. A "kink" is a short "swing."

Swing-train, n.—A train which conveys track material from the material yard to the front.

Switch, n.—A switch is a device for shifting the route at the entrance of a turnout. (Camp.)

Switch, n.—See (1) Channel switch. (2) Double slip switch. (3) Intermediate switch. (4) Single slip switch. (5) Slip switch. (6) Stub switch. (7) Three throw switch. (8) Three way switch.

Switch, v. t.—To distribute cars in a desired order, by using switching tracks.

Switch lug, n.—The appliance which is fastened to a switch point, and to which the switch rods are connected.

Switch plate, n.—See Slide Plate.

Switch-point, n.—"Reinforced switch point." A switch point to the side of which is bolted a flat iron bar stiffener.

Switch rod, n.—A transverse bar or rod connecting the two point rails of a switch.

Switch stand, n.—See (1) Automatic switch stand. (2) Ground switch stand. (3) High switch stand. (4) Intermediate switch stand. (5) Jack knife switch stand. (6) Low switch stand. (7) Safety switch stand. (8) Three throw stand.

Switching district, n.—That portion of a railway at a large terminal into which cars are moved, and from which they are distributed to the various sidetracks and spurs to freight houses and manufacturing establishments served from this district, by yard or switching engines.

Tallow-pot, n.—A locomotive fireman.

Tamp, v. i.—(1) To pack down with light blows in grading. (2) To compact earth or ballast under track ties.

Tamp.—(1) "Shovel tamping." Tamping track with shovels

only. (2) "Bar tamping." Tamping with tamping bars. (3) "Pick tamping." Tamping stone ballast with tamping picks.

Tangent, n.—Straight track.

Taper rail, n.—A rail tapered down from a heavy to a lighter section, to be used in place of a compromise joint between two rails of different size.

Tapped tie, n.—A tie made from a tree, the resin or turpentine of which has been extracted before felling.

Target, n.—The day signal used on a switch stand.

Team-track, n.—A track from which cars are loaded or unloaded into wagons.

Tell-tale, n.—See Whip Guard Signal.

Terminal, n.—The facilities provided by a railway at a terminus or at intermediate points on its line for the purpose of handling its business.

Terminal, n.—Freight terminal. The arrangement of terminal facilities for the handling of freight business.

Terminal, n.—Passenger terminal. The arrangement of terminal facilities for the handling of passenger business.

Terminal, n.—Rail and water terminal. A terminal where freight is interchanged between railway cars and vessels.

Terrier, n.—An experienced itinerant track laborer.

Third rail, n.—(1) A rail placed between two rails at standard gage, to provide for narrow gage operation by using in connection with one of the standard gage rails. (2) A rail which carries the propulsion current on an electrically-operated railway.

Three-level crossing, n.—A crossing in which the roads are at three different heights or elevations.

Three-rail track, n.—A track with three rails, to accommodate both standard and narrow gage equipment.

Three-throw stand.—A switch stand for a three-way switch.

Three-way switch, n.—A switch placed where two side tracks diverge from a main track at a common point.

Three-tie joint, n.—A joint in which the angle bars rest on three ties, the central tie being directly beneath the meeting of the rails.

Throat, n.—The open portion of the frog where the rails are closest together. (Camp.)

Throat-cut, n.—"Throat-cut spike." A spike into which a notch has been worn where it is in contact with the rail base.

Throw, n.—(1) The distance the switch points move when the switch is lined from one route to the other. (2) The distance a curve is to be moved at any certain place, to conform to the stakes or to its correct line.

Tickler, n.—A warning signal for a bridge, consisting of a number of evenly spaced cords suspended over a track, the lower ends of the cords being at such a height that a man standing on top of a car will be struck by the cords. Same as Tell Tale or Whip-Guard Signal.

Tickler pole, n.—A pole which supports a tickler signal on a projecting horizontal cross arm.

Tie, n.—See (1) Cross tie. (2) Cull tie. (3) Doty tie. (4) Heart tie. (5) Hewed tie. (6) Half round tie. (7) Pecky tie. (8) Pole tie. (9) Quartered tie. (10) Sap tie. (11) Sawed tie. (12) Slab tie. (13) Slabbed tie. (14) Split tie. (15) Strict heart tie. (16) Tapped tie. (17) Wane tie. (18) Pickled tie. (19) Treated tie. (20) Rail cut tie.

Tie buckers, n.—Men who carry ties out ahead of a track machine.

Tie face, n.—(1) The upper or lower plane surface of a tie (technical). (2) The upper surface of a tie.

Tie-line, n.—A rope used to show the proper lateral position for ties which are being distributed for a track.

Tie-liner, n.—A laborer who places ties in proper line.

Tie plate, n.—A plate placed between the tie and the rail to increase the bearing surface in order to prevent the rail from cutting into the tie and to hold the rails to gage.

Tie-plate gage, n.—A device which is placed on top and with one end even with the end of the tie, with holes arranged so that in this position they show the proper location for tie plates.

Tie-plater, n.—The laborer who places tie plates on the ties.

Tie plug, n.—A short piece of wood used to fill a hole left in a tie where a spike has been pulled.

Tie-pole, n.—A pole which has marks on it to show the proper distances center to center for track ties, and which is used in spacing ties.

Tie-spacer, n.—A laborer who places ties at their proper distance center to center ready for laying rails.

Tie-trammer, n.—A laborer who rolls the ties from the tie car into the trams on a track machine.

Tight gage, n.—Track in which the rails are closer than the standard track gage of the road.

Tight track, n.—Track with too small an allowance for expansion.

Time, n.—"To give a man his time." To discharge a man.

Toe, n.—"Toe of frog." The end of the frog nearest the switch point.

Toe, n.—"Toe of slope." The intersection of a slope with the ground surface in embankments. and the plane of roadbed in cuts.

Toe-casting, n.—A casting used between the toe rails of a spring rail frog.

Toe-in, v. t.—To "toe-in" a frog against another rail; to place the toe of the frog against the end of a rail in the track.

Top-of-slope, n.—The intersection of a slope with the ground surface in cuts, and the plane of the roadbed on embankments.

Track, n.—Ties, rails and fastenings with all parts in their proper relative positions.

Track, n.—See (1) Body track. (2) Cinder track. (3) Corduroy track. (4) Crossover track. (5) Dead track. (6) Dirt track. (7) Distribution track. (8) Drill track. (9) Gauntlet track. (10) House track. (11) Industry track. (12) Ladder track. (13) Lead track. (14) Loading track. (15) Mud track. (16) Open track. (17) Passing track. (18) Pit track. (19) Receiving track. (20) Relief track. (21) Running track. (22) Run-around-track. (23) Scale track. (24) Siding or side track. (25) Skeleton track. (26) Slewed track. (27) Special track. (28) Spur track. (29) Stub track. (30) Team track. (31) Three-rail track. (32) Tight track. (33) Transfer track. (34) Unloading track. (35) Wye track.

Track-bolt, n.—A bolt used in a track joint.

Track circuit, n.—An electric circuit carried through the rails of a track.

Track-chisel, n.—A chisel used for cutting rails.

Track-gage, n.—A tool for measuring the distance between track rails.

Track map, n.—A map used primarily for showing existing physical conditions, including tracks, bridges, buildings, water service and mains, leases, station facilities and all of the physical and operating features.

Track-walker, n.—A laborer who walks over the track to discover and repair or report breakages.

Traffic, n.—"Against traffic." In a direction opposite to the direction trains run.

Traffic, n.—"With traffic." In the same direction as the direction trains run.

Trailing movement, n.—A movement over a switch from frog to switch points.

Trailing point, n.—A switch or frog which points in the same direction as the movement of trains.

Train, n.—See (1) Gravel train. (2) Stone train. (3) Swing train. (4) Work train.

Trams, n.—Live rollers for conveying ties and rails to the front of a track-laying machine.

Transfer slip, n.—A protected landing place for car floats, with an adjustable apron for connecting the tracks of the pier and the car float.

Transfer tracks, n.—(1) Tracks used in conjunction by two railroads for the interchange of cars. (2) Tracks laid close together to facilitate the transfer of freight from one car to another.

Treated tie, n.—A track tie which has been subjected to a treatment to lengthen its life.

Trimmed car, n.—A car loaded with rails and enough angle bars to build the whole into track.

Trunking, n.—A continuous wooden box for the protection of wires carrying electric current.

Trunk-line, n.—A large railway.

Turnout, n.—An arrangement by which a car may pass from one track to another. (Camp.)

Two-level crossing, n.—A track crossing in which the roads are at two different heights or elevations.

Unloading track, n.—A track from which cars are unloaded.

Vertical curve, n.—A curve used to connect intersecting grade lines.

Walker, n.—Same as "general foreman" or "walking boss."

Walking-boss, n.—Same as "walker" or "general foreman."

Wane tie, n.—A squared tie showing parts of the original surface of the tree on one or more corners.

Waste, n.—Material in excess of that required to make an embankment of given cross section.

Web, n.—"Web of rail." The part of the rail between the ball and the base.

Weed-cutter, n.—A sharp spade-like tool with a long handle, for rooting up weeds.

Wheeler, n.—A dirt scraper mounted on wheels.

Whip, v. i.—"To whip a spike." To draw a spike, when driving it, to a different vertical position from that in which it was set.

Whip guard signal, n.—A device for warning freight trainmen that they are approaching an overhead bridge. The signal consists of a series of heavy cords hung several inches apart and at a height such that the ends of the cords will strike a trainman who is standing on top of a moving freight car.

Wide gage, n—(1) Uniform gage wider than standard used on curves. (2) Gage of track where the rails have spread.

Wing, n.—The outside of a frog back of the point.

Wing rail, n.—The outside rail of a frog back of the point.

Work train, n.—A train engaged in construction or maintenance work.

Work ways, v. i.—A command to turn a rail ball up.

Work ways, adv.—The position of a rail which corresponds to its position when in track. Right side up.

Wye track, n.—Same as "Y-track."

Yard, n.—A system of tracks arranged in series, within defined limits, for separating and making up trains, storing cars, and other purposes.

Yard, n.—See (1) Classification yard. (2) Cluster or general yard. (3) Departure or forwarding yard. (4) Distribution yard. (5) Freight yard. (6) Gravity yard. (7) Material yard. (8) Passenger yard. (9) Poleing yard. (10) Receiving yard. (11) Separating yard. (12) Storage yard. (13) Summit or hump yard.

Y-track, n.—A triangular arrangement of tracks used in place of a turntable for turning engines, cars or trains; or for transferring a train from one to another of two intersecting tracks.

TABLE 1.

TEMPERATURE EXPANSION FOR LAYING RAILS*

The allowance that should be made for expansion for 33-ft. rails is shown in the following table.

The temperature should be taken on the rail, and the openings between the rail ends should be as follows:

Temperature (Fahrenheit)	Allowance
—20° to 0°	5/16 in.
0° to 25°	1/4 in.
25° to 50°	3/16 in.
50° to 75°	1/8 in.
75° to 100°	1/16 in.

Over 100 degrees rails should be laid close without bumping.

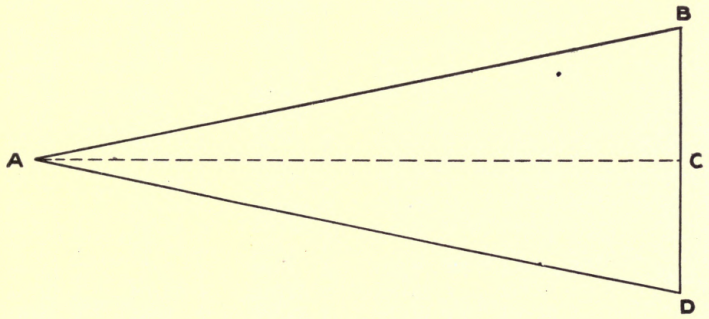


Fig. 47, Frog Board.

TABLE 2.

FROG-BOARD DIMENSIONS.

Frog No.	Length A C Ft.	In.	Width B D Inches	Frog No.	Length A C Ft.	In.	Width B D Inches
4	4	0	12	9	6	0	8
5	5	0	12	10	5	0	6
6	5	0	10	11	5	6	6
7	5	3	9	12	6	0	6
8	6	0	9	15	6	3	5

*American Railway Engineering Association.

TABLE 3.

MIDDLE ORDINATES IN INCHES, FOR CURVING RAILS.

Degree of Curve	Length of Rail. 33 Ft.	30 Ft.	26 Ft.	20 Ft.	16 Ft.
3°	55/64	11/16	17/32	5/16	13/64
3° 30′	1	27/32	5/8	3/8	15/64
4°	1 9/64	61/64	23/32	27/64	9/32
4° 30′	1 9/32	1 1/16	13/16	15/32	5/16
5°	1 27/64	1 3/16	57/64	17/32	11/32
5° 30′	1 37/64	1 19/64	63/64	37/64	3/18
6°	1 45/64	1 13/32	1 1/16	5/8	13/32
6° 30′	1 27/32	1 17/32	1 11/64	11/16	7/16
7°	1 63/64	1 21/32	1 1/4	47/64	15/32
7° 30′	2 9/64	1 3/4	1 21/64	25/32	1/2
8°	2 9/32	1 7/8	1 27/64	27/32	17/32
8° 30′	2 27/64	2	1 33/64	57/64	37/64
9°	2 9/16	2 3/32	1 19/32	15/16	39/64
9° 30′	2 45/64	2 15/64	1 11/16	1	41/64
10°	2 27/32	2 11/32	1 25/32	1 3/64	11/16
11°	3 1/8	2 19/32	1 61/64	1 5/32	3/4
12°	3 13/32	2 13/16	2 9/64	1 17/64	53/64
13°	3 45/64	3 3/64	2 9/32	1 23/64	29/32
14°	3 63/64	3 5/16	2 31/64	1 15/32	61/64
15°	4 17/64	3 35/64	2 43/64	1 37/64	1 1/64
16°	4 35/64	3 3/4	2 53/64	1 43/64	1 3/32
17°	4 27/32	4	3 1/32	1 25/32	1 5/32
18°	5 7/64	4 7/32	3 3/16	1 7/8	1 15/64
19°	5 13/32	4 29/64	3 23/64	1 63/64	1 19/64
20°	5 63/64	4 45/64	3 35/64	2 3/32	1 3/8

TABLE 4

DIRECT DISTANCES BETWEEN LADDER FROG POINTS, MEASURED ALONG LADDER.

No. of Frog	Distances Between Track Centers, Ft. 12 ft.	12 in.	12½ ft.	12½ in.	13 ft.	13 in.	13½ ft.	13½ in.	14 ft.	14 in.	14½ ft.	14½ in.	15 ft.	15 in.
6	72	6	75	6¼	78	6½	81	6¾	84	7	87	7¼	90	7½
7	84	5	87	11⅜	91	5⅝	94	11¾	98	6	102	0¼	105	6½
8	96	4½	100	4¾	104	5	108	5	112	5¼	116	5½	120	5⅝
9	108	4	112	10⅛	117	4¼	121	10½	126	4⅝	130	10⅜	135	5
10	120	3½	125	3¾	130	4	135	4⅛	140	4¼	145	4⅜	150	4⅝
11	132	3¼	137	9⅜	143	3⅝	148	9⅝	154	3¾	159	10	165	4⅛
12	144	3	150	3	157	3	162	3⅛	168	3½	174	3½	180	3¾
14	168	2½	175	2⅝	182	2¾	189	2⅞	196	3	203	3⅛	210	3¼

TABLE 5.

WIDENING GAGE ON CURVES.

From The Manual of the A. R. E. Association.

Curves eight degrees and under should be standard gage. Gage should be widened one-eighth inch for each two degrees or fraction thereof over eight degrees, to a maximum of 4 ft. 9¼ in. for tracks of standard gage. Gage, including widening due to wear, should never exceed 4 ft. 9½ in.

The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where same is unavoidable, the above rule should be modified in order to make the gage of the track at the frog standard.

The following table is made up from the above rule.

Degree	Increase Gage by	Correct Gage	Correct Distance Between Rail and Guard Rail
Up to 8 degrees	0 in	4 ft. 8½ in.	1¾ in.
8 degrees			
9 degrees	⅛ in.	4 ft. 8⅝ in.	1⅞ in.
10 degrees			
11 degrees	¼ in.	4 ft. 8¾ in.	2 in.
12 degrees			
13 degrees	⅜ in.	4 ft. 8⅞ in.	2⅛ in.
14 degrees			
15 degrees	½ in.	4 ft. 9 in.	2¼ in.
16 degrees			
17 degrees	⅝ in.	4 ft. 9⅛ in.	2⅜ in.
18 degrees			
19 degrees	¾ in.	4 ft. 9¼ in.	2½ in.
20 degrees			
20 degrees	⅞ in.	4 ft. 9⅜ in.	2⅝ in.
21 degrees			
22 degrees			
and above	1 in.	4 ft. 9½ in.	2¾ in.

TABLE 6.

SETS OF SWITCH TIES FOR VARIOUS TURNOUTS.

Frog No.	Space in Track	Split Switches. No. of Tie of Each Length 15	8	9	10	11	12	13	14	Total Number
14	140′	2	12	10	14	12	10	8	6	74
12	120′	1	0	13	11	9	6	7	7	54
10	100′	2	9	14	8	7	7	4	4	55
8	75′	2	9	10	9	6	6	5	2	49
7	70′	2	9	8	6	6	5	4	2	42
6	60′	2	8	7	5	4	3	4	2	35
5	50′	2	6	6	3	3	2	4	2	28

TABLE 7.

THEORETICAL SWITCH LEADS.

Frogs.											Theoretical Leads.				
N—Frog Number	W—Length, Point to Toe		K—Length, Point to Heel		Total Length		Spread at Toe	Spread at Heel	S—Length of Switch Rail		R—Radius of Center Line	D—Degree of Lead Curve			Distance Point of Switch Rail to Theoretical Point of Frog
	Ft.	In.	Ft.	In.	Ft.	In.	Feet	Feet	Ft.	In.	Feet	Deg.	Min.	Sec.	Feet
4	3	2	5	4	8	6	0.79	1.32	11	0	112.26	52	53	56	37.05
5	3	7	6	5	10	0	0.71	1.28	11	0	183.22	31	40	24	42.77
6	4	0	7	0	11	0	0.66	1.16	11	0	273.95	21	01	58	48.11
7	4	5	8	1	12	6	0.63	1.15	16	6	364.88	15	47	19	61.94
8	4	9	8	9	13	6	0.59	1.09	16	6	488.71	11	44	40	67.47
9	6	0	10	0	16	0	0.67	1.11	16	6	616.27	9	18	27	72.24
9½	6	0	10	0	16	0	0.63	1.05	16	6	699.97	8	11	33	74.90
10	6	0	10	6	16	6	0.60	1.05	16	6	790.25	7	15	18	77.51
11	6	0	11	6	17	6	0.54	1.05	22	0	940.21	6	05	48	92.06
12	6	5	12	1	18	6	0.53	1.01	22	0	1136.34	5	02	38	97.25
15	7	8	14	10	22	6	0.51	0.99	33	0	1744.38	3	17	01	133.02
16	8	0	16	0	24	0	0.50	1.00	33	0	2005.98	2	51	24	135.95
18	8	10	17	8	26	6	0.49	0.98	33	0	2587.66	2	12	52	146.38
20	9	8	19	4	29	0	0.48	0.97	33	0	3262.98	1	45	22	156.35
24	11	4	23	2	34	6	0.47	0.97	33	0	4932.77	1	09	42	175.09

*American Railway Engineering Association.

TABLE 8.

PRACTICAL LEADS FOR SWITCHES.

No. of Frog	Theoretical Lead ft. in.	Distance Point to Toe of Frog ft. in.	Switch Rail ft. in.	Net Length of Lead Rails (theoretical) ft. in.	Practical Length of Rail to Use ft.	No. and Lengths of Rail to Use.
4	37 0	3 2	11 0	22 10	20	One 20 ft. Rail.
5	42 9	3 7	11 0	28 2	28	One 28 ft. Rail.
6	48 1	4 0	11 0	33 1	33	One 33 ft. Rail.
7	62 0	4 5	16 6	41 1	45	One 30 ft. and one 15 ft. Rail.
8	67 6	4 9	16 6	46 3	45	One 30 ft. and one 15 ft. Rail.
9	72 3	6 0	16 6	49 9	49½	One 33 ft.; and one 16½ ft. Rail.
9½	74 11	6 0	16 6	52 5	49½	One 33 ft; one 16½ ft.
10	77 6	6 0	16 6	55 0	49½	Two 30 ft. Rails.
11	92 0	6 0	22 0	64 0	60 (or 66)	Two 30 ft. (or two 33 ft.)
12	97 3	6 5	22 0	68 10	66	Two 33 ft. Rails.
15	133 0	7 8	33 0	92 4	90 (or 99)	Three 30 ft. (or three 33 ft.)
16	136 0	8 0	33 0	95 0	90 (or 99)	Three 30 ft. (or three 33 ft.)
18	146 5	8 10	33 0	104 7	99	Three 33 ft.
20	156 4	9 8	33 0	113 8	99	Three 33 ft.
24	175 1	11 4	33 0	130 9	120	Four 30 ft.

Note—This table is based on the frog lengths and switch-rail lengths recommended by the American Railway Engineering Association.

TABLE 9.

SPACING OF CROSS TIES (SQUARE JOINTS).

Note—Joint ties assumed to be 9 in. from end of rail.

Length of Rail or Panel ft.	Spacing 12 ties per rail ft. in.	Spacing 13 ties per rail ft. in.	14 ties ft. in.	15 ties ft. in.	16 ties ft. in.	17 ties ft. in.	18 ties ft. in.	19 ties ft. in.	20 ties ft. in.	Spacing 21 ties per rail ft. in.
28	2 5	2 2½	2 0½	1 10¾	1 9¼					
29			2 1¼	1 11½	1 10	1 8½				
30			2 2¼	2 0¼	1 10¾	1 9¼	1 8	1 7		
31				2 1¼	1 11½	1 10	1 8¾	1 7¾		
32				2 2	2 0½	1 10¾	1 9½	1 8¼	1 7¼	
33					2 1¼	1 11½	1 10¼	1 9	1 7¾	1 6¾

TABLE 10.

NUMBER OF TIES PER MILE WHEN EXPRESSED IN NUMBER PER 100 FEET.

No. of Ties in 100 Ft.	No. of Ties in 1 Mile	No. of Ties in 100 Ft.	No. of Ties in 1 Mile
40	2112	53	2798
41	2164	54	2851
42	2218	55	2904
43	2270	56	2957
44	2323	57	3009
45	2376	58	3062
46	2429	59	3115
47	2482	60	3168
48	2534	61	3220
49	2587	62	3274
50	2640	63	3326
51	2693	64	3379
52	2745	65	3332

TABLE 11.

ELEVATION OF OUTER RAIL IN INCHES.*

Degree of Curve	Velocity in Miles per Hour.													Degree of Curve
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1	0	1/8	1/4	3/8	5/8	3/4	1 1/8	1 3/8	1 5/8	2	2 3/8	2 3/4	3 1/4	1
2	1/8	3/8	1/2	7/8	1 1/8	1 5/8	2 1/8	2 5/8	3 1/4	4	4 3/4	5 1/2	6 1/2	2
3	1/4	1/2	3/4	1 1/4	1 3/4	2 3/8	3 1/8	4	4 7/8	6	7 1/8	8 3/8	9 3/4	3
4	1/4	5/8	1	1 5/8	2 3/8	3 1/4	4 1/4	5 3/8	6 5/8	8	9 1/2	...	...	4
5	3/8	3/4	1 1/4	2	3	4	5 1/4	6 5/8	8 1/4	...	...	...	...	5
6	3/8	1	1 5/8	2 1/2	3 1/2	4 7/8	6 1/4	8	...	...	...	...	...	6
7	1/2	1 1/8	1 7/8	2 7/8	4 1/8	5 5/8	7 3/8	...	...	...	...	...	...	7
8	1/2	1 1/4	2 1/8	3 1/4	4 3/4	6 1/2	8 3/8	...	...	...	...	...	...	8
9	5/8	1 3/8	2 3/8	3 3/4	5 3/8	7 1/4	...	...	...	...	...	...	...	9
10	3/4	1 1/2	2 5/8	4 1/8	5 7/8	8 1/8	...	...	...	...	...	...	...	10
11	3/4	1 3/4	2 7/8	4 1/2	6 1/2	8 7/8	...	...	...	...	...	...	...	11
12	7/8	1 7/8	3 1/8	4 7/8	7 1/8	...	...	...	...	...	...	...	...	12
13	7/8	2	3 3/8	5 3/8	7 3/4	...	...	...	...	...	...	...	...	13
14	1	2 1/8	3 5/8	5 3/4	8 3/8	...	...	...	...	...	...	...	...	14
15	1	2 1/4	3 7/8	6 1/4	8 7/8	...	...	...	...	...	...	...	...	15
16	1 1/8	2 1/2	4 1/4	6 5/8	...	...	...	...	...	...	...	...	...	16
17	1 1/4	2 5/8	4 1/2	7	...	...	...	...	...	...	...	...	...	17
18	1 1/4	2 3/4	4 3/4	7 1/2	...	...	...	...	...	...	...	...	...	18
19	1 3/8	2 7/8	5	7 3/4	...	...	...	...	...	...	...	...	...	19
20	1 3/8	3	5 1/4	8 1/8	...	...	...	...	...	...	...	...	...	20

*American Railway Engneering Association.

TABLE 12.

LADDER LAYOUT TABLE.

Distance from Straight Track to Gage Line of Frog Rail of Ladder at

Frog No.	100 Ft. Ft. In.	200 Ft. Ft. In.	300 Ft. Ft. In.	400 Ft. Ft. In.	500 Ft. Ft. In.
6	16—9⅜	33—6¾	50—4¼	67—1⅝	83—11
7	14—4¼	28—8⅝	43—1	57—5¼	71—9½
8	12—6⅝	25—1⅛	37—7¾	50—2⅜	62—9
9	11—1¾	22—3½	33—5⅛	44—6⅞	55—8⅝
10	10—0⅜	20—0⅝	30—1	40—1¼	50—1⅝
11	9—1⅜	18—2⅝	27—4	36—5¼	45—6⅝
12	8—4⅛	16—8⅜	25—0½	33—4¾	41—8⅞

TABLE 13.

DEGREE OF TURNOUT CURVE WHEN FROG IS ON THE INSIDE OF THE CURVE.

Frog No.	Turnout Curve from Straight Track deg.	Degree of Curve in Main Track. 1 deg.	2 deg.	3 deg.	4 deg.	5 deg.	6 deg.	7 deg.	8 deg.	9 deg.
6	17	18	19	20	21	22	23	24	25	26
7	12½	13½	14½	15½	16½	17½	18½	19½	20½	21½
8	9½	10½	11½	12½	13½	14½	15½	16½	17½	18½
9	7½	8½	9½	10½	11½	12½	13½	14½	15½	16½
10	6	7	8	9	10	11	12	13	14	15
11	5	6	7	8	9	10	11	12	13	14
12	4	5	6	7	8	9	10	11	12	13
15	2½	3½	4½	5½	6½	7½	8½	9½	10½	11½

TABLE 14.

DEGREE OF TURNOUT CURVE WHEN FROG IS ON THE OUTSIDE OF CURVE.

Frog No.	Turnout Curve from Straight Track deg.	Degree of Curve in Main Track. 1 deg.	2 deg.	3 deg.	4 deg.	5 deg.	6 deg.	7 deg.	8 deg.	9 deg.
4	38½	37½	36½	35½	34½	33½	32½	31½	30½	29½
5	24½	23½	22½	21½	20½	19½	18½	17½	16½	15½
6	17	16	15	14	13	12	11	10	9	8
7	12½	11½	10½	9½	8½	7½	6½	5½	4½	3½
8	9½	8½	7½	6½	5½	4½	3½	2½	1½	
9	7½	6½	5½	4½	3½	2½	1½			
10	6	5	4	3	2	1				

TABLE 15.

SPACING OF CROSSTIES (BROKEN JOINTS).

Note—Joint ties assumed to be 9 in. from end of rail.

Length of Rail or Panel ft.	Spacing 12 ties per rail ft. in.	Spacing 14 ties per rail ft. in.	Spacing 16 ties per rail ft. in.	Spacing 18 ties per rail ft. in.	Spacing 20 ties per rail ft. in.	Spacing 22 ties per rail ft. in.
30		2 3	1 11	1 8¼	1 6	
31		2 4	2 0	1 9	1 6¾	
32		2 5	2 1	1 9¾	1 7½	1 5½
33		2 6	2 1¾	1 10½	1 8	1 6

TABLE 16.

DIMENSIONS OF RAILS.

Type	Weight per Yd.	Height	Base.	Head
A. S. C. E.	100	5¾	5¾	2¾
A. S. C. E.	90	5⅜	5⅜	2⅝
A. S. C. E.	85	5¼	5¼	2½
A. S. C. E.	80	5	5	2½
A. S. C. E.	72	4¾	4¾	2⅜
A. S. C. E.	70	4⅝	4⅝	2½
A. S. C. E.	65	4½	4½	2⅜
A. S. C. E.	60	4¼	4¼	2⅜
A. R. A.-A	100	6	5½	2¾
A. R. A.-A	90	5⅝	5⅛	2 9/16
A. R. A.-A	80	5⅛	4⅝	2½
A. R. A.-A	70	4¾	4¼	2⅜
A. R. A.-A	60	4½	4	2¼
A. R. A.-B	100	5⅝	5⅛	2⅝
A. R. A.-B	90	5¼	4¾	2½
A. R. A.-B	80	4⅞	4⅛	2½
A. R. A.-B	70	4½	4 1/16	2⅜
A. R. A.-B	60	4⅛	3⅝	2⅛

TABLE 17.

CUBIC YARDS OF BALLAST REQUIRED FOR VARIOUS DEPTHS BELOW TOP OF TIE.

Top Width Single Track	Cubic Yds. per 100 Ft.				Cubic Yds. per Mile			
	Depth Below Top of Tie				Depth Below Top of Tie			
	9 in.	12 in.	15 in.	18 in.	9 in.	12 in.	15 in.	18 in.
10	22.26	33.14	44.48	56.28	1177	1739	2370	2980
11	25.03	36.84	49.11	61.83	1342	1947	2600	3270
12	27.80	40.54	53.74	67.38	1468	2143	2840	3650
Double Track								
22	48.00	69.94	96.14	115.35	2540	3700	5080	6100
23	50.76	73.64	100.77	120.90	2680	3900	5320	6390
24	52.72	77.00	103.99	124.13	2780	4060	5490	6550

TABLE 18.

NUMBER OF JOINTS, ANGLE BARS AND TIES PER MILE OF SINGLE TRACK.

Length of Rail	No. of Rail Lengths Per Mile	No. of Pairs Angle Bars Per Mile	Number of Ties Spaced to Rail Length. 10	11	12	13	14	15	16	17	18	19	20	21
24 feet	220	440	2200	2420	2640	2860	3080	3300	....	....	....	....	....	....
25 feet	211.5	422	2115	2326	2538	2750	2961	3172	....	....	....	....	....	....
26 feet	203	406	....	2233	2436	2640	2842	3045	3268	....	....	....	....	....
27 feet	195.5	391	....	2150	2346	2541	2737	2932	3128	....	....	....	....	....
28 feet	188.5	377	....	....	2262	2450	2640	2827	3016	3204	....	....	....	....
29 feet	182.4	365	....	....	2189	2371	2554	2736	2918	3108	3283	....	....	....
30 feet	176	352	....	....	2164	2356	2534	2640	2851	3009	3168	....	....	....
31 feet	170.3	341	....	....	....	2214	2384	2555	2725	2895	3065	3235	....	....
32 feet	165	330	....	....	....	2145	2310	2475	2640	2805	2970	3135	3300	....
33 feet	160	320	....	....	....	2080	2240	2400	2560	2720	2880	3040	3200	3360

TABLE 19.

DISTANCES ALONG MAIN TRACK BETWEEN CROSSOVER FROG POINTS.

Distances Between Track Centers, Ft.

No. of Frog	12 ft.	in.	12½ ft.	in.	13 ft.	in.	13½ ft.	in.	14 ft.	in.	14½ ft.	in.	15 ft.	in.
6	14	6	17	5¾	20	5½	23	5¼	26	5	29	5¾	32	4½
7	17	0⅞	20	6⅝	24	0⅜	27	6¼	31	0	34	5¾	37	11½
8	19	7½	23	7¼	27	7⅛	31	7	35	6¾	39	6⅝	43	6⅜
9	22	11	27	4⅞	31	10¾	36	4½	40	10⅜	45	4⅛	49	10
10	24	8⅝	29	8¼	34	8⅛	39	8	44	7¾	49	7⅝	54	7½
11	27	2¾	32	8⅝	38	0½	43	6⅜	49	0⅛	54	6	60	1⅞
12	29	9⅛	35	8⅞	41	8¾	47	8	53	8½	59	8	65	8¼
14	34	9¾	41	9¼	48	9¼	55	9⅜	62	9	69	8⅞	76	8¾
15	38	6⅝	46	0½	53	6⅜	61	0¼	68	6¼	70	0⅛	83	6⅛
16	39	9¾	47	9⅝	56	9⅝	63	9½	71	9⅜	79	9½	87	9⅛
18	46	4	55	3⅞	64	3⅝	73	3¾	82	2⅜	91	3⅝	100	3½
20	49	10¼	59	10⅜	69	10	79	10	89	9⅞	99	9⅞	109	9¾

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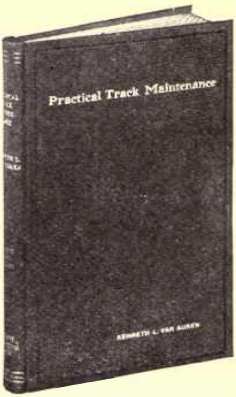

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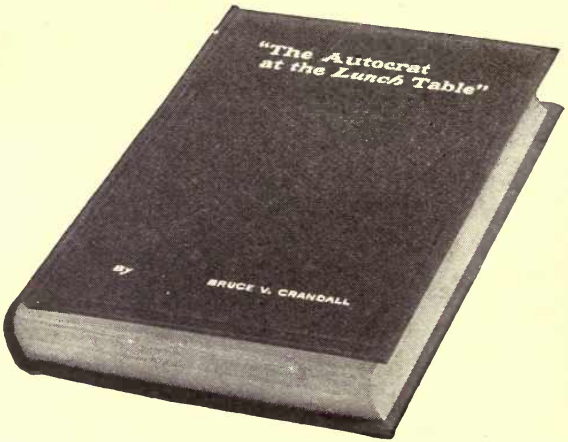

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